

BOUNDARY BAY



VETERINARY SPECIALTY HOSPITAL

24-Hour Specialty, Emergency & Critical Care
Langley, BC

“Wonky Back Ends”:

The clinician’s approach to hind limb weakness

Case Studies

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Case Study Goals

- Review gait evaluation videos
- Classify the character & type of lameness/weakness
- Form a differentials list
- Discuss ancillary diagnostics
- Determine referral goals



Formulating a Differentials List

- “VITAMIN D” vs. “DAMNIT V” acronym
 - Vascular
 - Inflammatory/infectious
 - Trauma
 - Anomalous
 - Metabolic
 - Idiopathic
 - Neoplasia
 - Degenerative





Case 1

Case Studies

10 yo FS Pitbull mix

- **History:** 1 year history of progressive hind end weakness, with acute non-weightbearing lameness on left hind 1 month ago
 - Weakness started in both hind legs, with reduced exercise tolerance
 - Acute limping started when she got off her bed, no trauma witnessed
 - Started toe-touching on the left hind 3-4 days ago, after starting Metacam and gabapentin
 - Not perceived to be in pain by owner – no yelping or crying at home.





10 yo FS Pitbull mix

■ Ortho Exam Findings:

- Gait: Grade 3 LH lameness, grade 2 RF lameness
- Thoracic limbs: Right elbow thickening with mild effusion, reduced flexion; no other joint pain, effusion, instability, or altered range of motion identified in any joint; long bones palpate normally
- Right pelvic limb: Moderate stifle effusion without palpable medial buttress, no cranial drawer or tibial thrust elicited, mild discomfort on stifle hyperextension; hip, tarsus, digits, and long bones palpate normally; no overt iliopsoas pain on direct palpation
- Left pelvic limb: Moderate stifle effusion with mild medial buttress, positive cranial drawer & tibial thrust, consistent click on stifle ROM concerning for meniscal injury; hip, tarsus, digits, and long bones palpate normally; no overt iliopsoas pain on direct palpation



10 yo FS Pitbull mix

■ Neuro Exam Findings:

- Mentation: Bright, alert, and responsive
- Gait/Posture: Weight-bearing lameness in left pelvic limb and right thoracic limb, no overt ataxia or paresis identified, normal stance
- Cranial Nerves: No cranial nerve deficits identified
- Postural reactions: Paw placement normal in all limbs with support, slightly delayed in pelvic limbs without support
- Spinal Reflexes: Withdrawals normal x4, patellar reflex normal x2, normal perineal reflex & anal tone
- Spinal Hyperesthesia: No pain elicited on palpation, normal cervical range of motion



10 yo FS Pitbull mix

- What kind of weakness? Neurologic or orthopedic?

ORTHOPEDIC – stifle, foot, tarsus, polyarthropathy

Less likely to be neurologic...

- Neurolocalization: Focal left L4-S3 (myelopathy vs. radiculopathy vs. neuropathy vs. junctionopathy vs. myopathy)



10 yo FS Pitbull mix

■ Differentials?

- Cranial cruciate ligament disease
- Immune-mediated polyarthropathy
- Digit foreign body/wound
- Digital corn
- Infectious arthropathy
- Neoplasia



Cranial Cruciate Ligament Disease

- **Common history:**

- History of recurrent short-term lameness over the months preceding acute persistent lameness
- No or only mild trauma preceding lameness
- Often improves slightly over 3-5 days of rest +/- NSAIDs

- **Exam findings:**

- Stifle effusion
- Positive cranial drawer +/- tibial thrust
 - Partial vs complete tear
- +/- Medial buttress
- +/- Crepitus

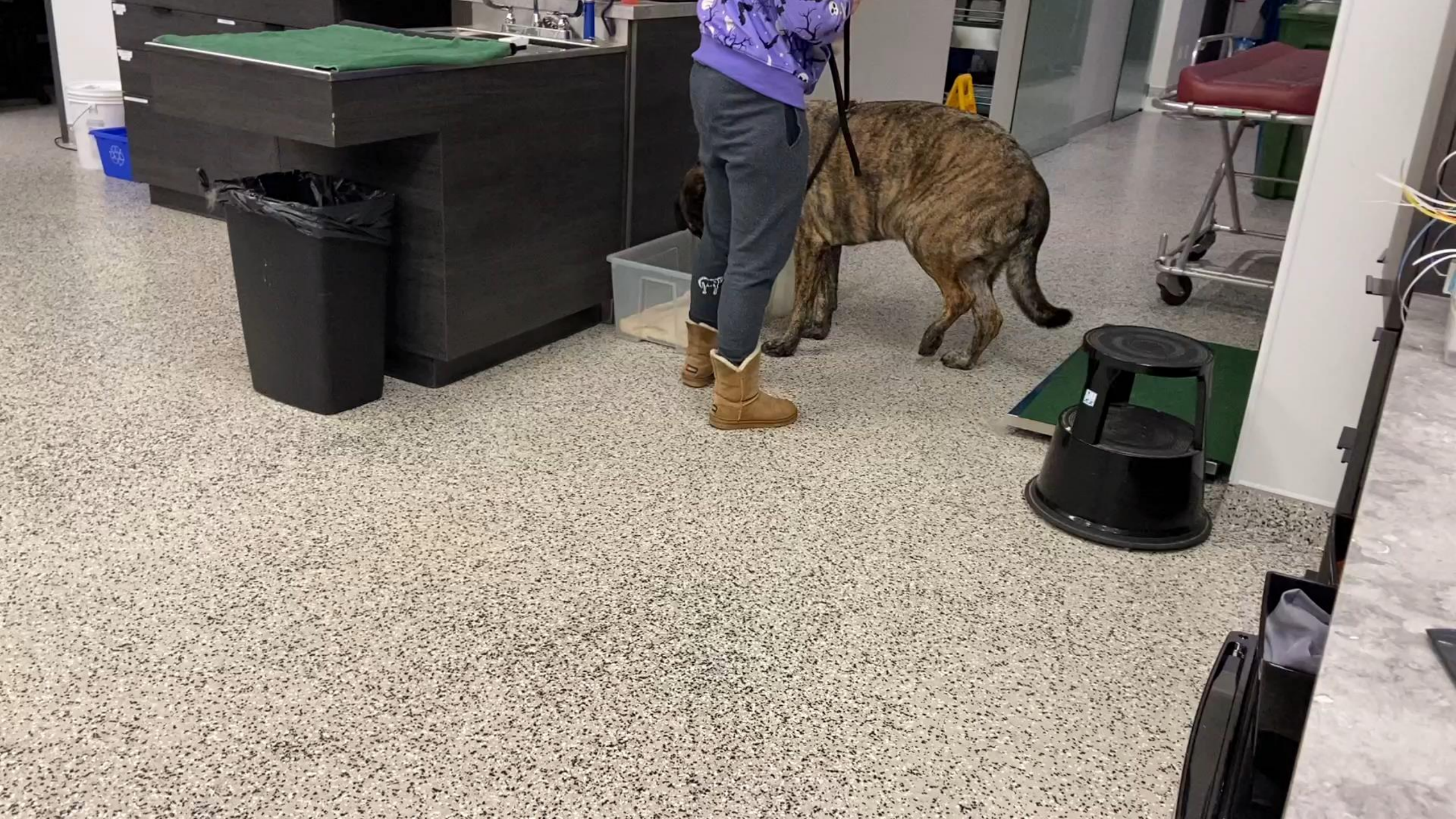


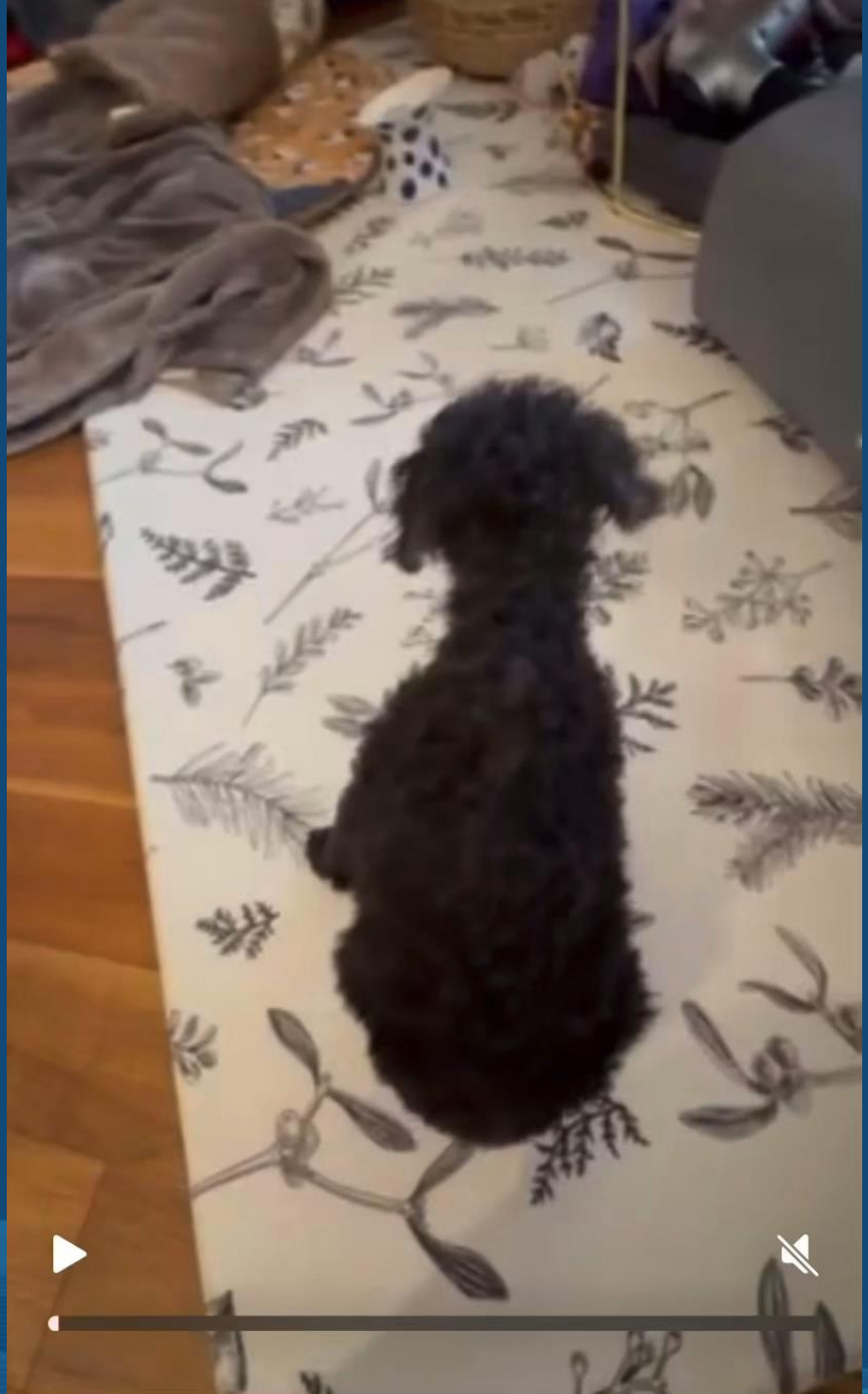
Cranial Cruciate Ligament Disease

- **Diagnostics:**
 - Orthogonal radiographs
 - Advanced imaging - US/MRI
 - Arthroscopic evaluation
- **Treatment Options:**
 - Conservative management
 - Extracapsular Suture Stabilization
 - Geometric Procedures
 - TPLO
 - TTA











Immune-Mediated Polyarthropathy

- **Common history:**
 - Generalized weakness / lethargy
 - Static to worse with time/rest
 - Minimal response to pain medications
 - Inappetence, generalized systemic illness
- **Exam findings:**
 - Multi-limb “walking on eggshells” gait
 - Multiple effusive joints without instability, often bilaterally symmetric
 - Pain on joint range of motion
 - Fever



Immune-Mediated Polyarthropathy

- **Diagnostics:**

- CBC/Chemistry, UA
- Tickborne disease testing
- Arthrocentesis for joint fluid cytology & culture
- Thoracic radiographs & abdominal ultrasound/CT
- Radiographs of affected joints - <1% erosive

- **Treatment Options:**

- Immunosuppression – 60% idiopathic
- Treat any underlying cause
 - Type II – Disease distant from joint (tickborne, vaccine, medication) – 25%
 - Type III – Enteropathic – 4%
 - Type IV – Paraneoplastic – 2%



Digit/Foot Injury

- **Common history:**
 - Acute onset of lameness, often non-weightbearing
 - Chewing/licking at foot
 - Corns - Greyhounds
- **Exam findings:**
 - Lameness often significant, off-loads when standing
 - Digit swelling +/- bruising
 - +/- Crepitus
 - +/- Draining tract



Digit/Foot Injury

- **Diagnostics:**

- Radiographs
- CT +/- fistulogram
- Ultrasound
- MRI
- Bacterial culture
- +/- Tissue biopsy

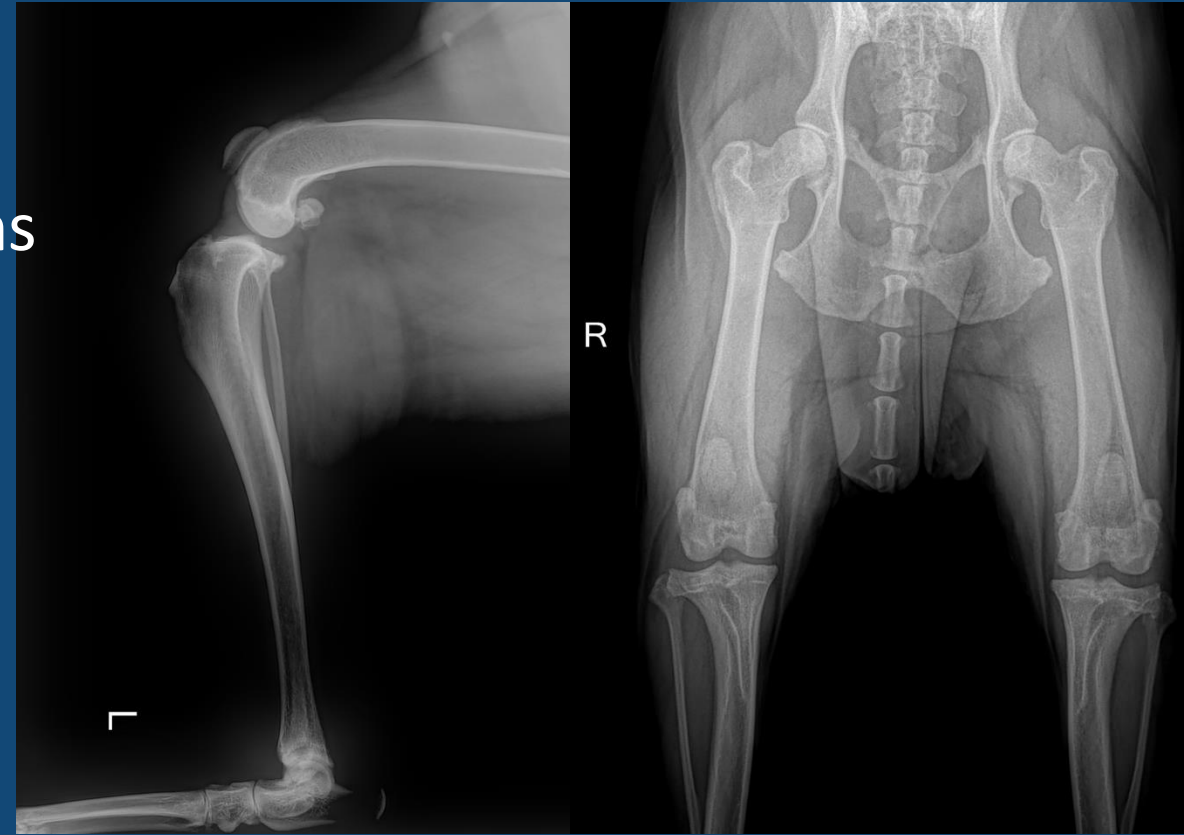
- **Treatment Options:**

- Surgical explore +/- stabilization
- Digit amputation
- Superficial digital flexor tenectomy - corns



10 yo FS Pitbull mix

- **Diagnostics:**
 - Orthogonal left stifle radiographs
- **Treatment:**
 - Left TPLO
 - Incompetent partial CCL tear
 - Intact meniscus





Case 2

Case Studies

5 yo MN French Bulldog

- **History:** 4 month history of slowly progressive hind limb scuffing
 - Started in right hind limb, more recently has been involving both hind limbs.
 - Not perceived to be in pain by owners – no yelping or crying at home.
 - Was referred to a neurologist at onset of signs; owner elected for conservative medical management





5 yo MN French Bulldog

- **Ortho Exam Findings:**
 - Gait: Bilateral pelvic limb gait anomaly without overt lameness
 - Thoracic limbs: No joint pain, effusion, instability, or altered range of motion identified in any joint; long bones palpate normally
 - Pelvic limbs: No stifle effusion or instability; no patellar luxation elicited bilaterally; hip, tarsus, digits, and long bones palpate normally; no overt iliopsoas pain on direct palpation



5 yo MN French Bulldog

■ Neuro Exam findings:

- Mentation: Bright, alert, responsive
- Gait/posture: ambulatory with moderate-severe UMN/GP paraparesis/ataxia in pelvic limbs; slightly "robotic" quality to pelvic limb movements suggestive of a chronic myelopathy
- Cranial nerves: normal
- Postural reactions: absent paw placement & delayed hopping in both pelvic limbs
- Segmental reflexes/muscle tone: mild global muscle atrophy of pelvic limbs, normal patellar x 2, normal withdrawal x 4, CT reflex cut-off around mid-thoracic region, perineal reflex normal
- Spinal hyperesthesia: no pain elicited on palpation of vertebral column



5 yo MN French Bulldog

- What kind of weakness? Neurologic or orthopedic?

NEUROLOGIC

- Neurolocalization: T3-L3 myelopathy



5 yo MN French Bulldog

- **Differentials?**

- Chronic intervertebral disc protrusion (IVDP)
- Vertebral malformation
- Subarachnoid diverticulum (SAD)
- Constrictive (fibrotic) myelopathy
- Neoplasia
- ~~Fibrocartilaginous embolism (FCE)~~



Vertebral malformations

- Very common in small brachycephalic dog breeds
- Prevalence of vertebral malformations in **neurologically normal** dogs:
 - French bulldog: ~70 – 93.5%
 - Pug: ~3.7 - 97%
 - English bulldog: ~24 - 84%
- Most affected dogs exhibit clinical signs by **one year of age**
 - Signs can also develop later in life



Vertebral malformations

- **Common history:**

- Often brachycephalic breeds (Frenchie, Pug, English bulldog), but can affect any breed
- Typically <1 year old; can be older if chronic instability & spinal cord damage
- Slow onset, progressive paraparesis & ataxia
- No evidence of pain

- **Exam findings:**

- Varying degrees of paraparesis & GP ataxia
- Proprioceptive deficits
- +/- Cutaneous trunci reflex deficits
- Lack of spinal pain



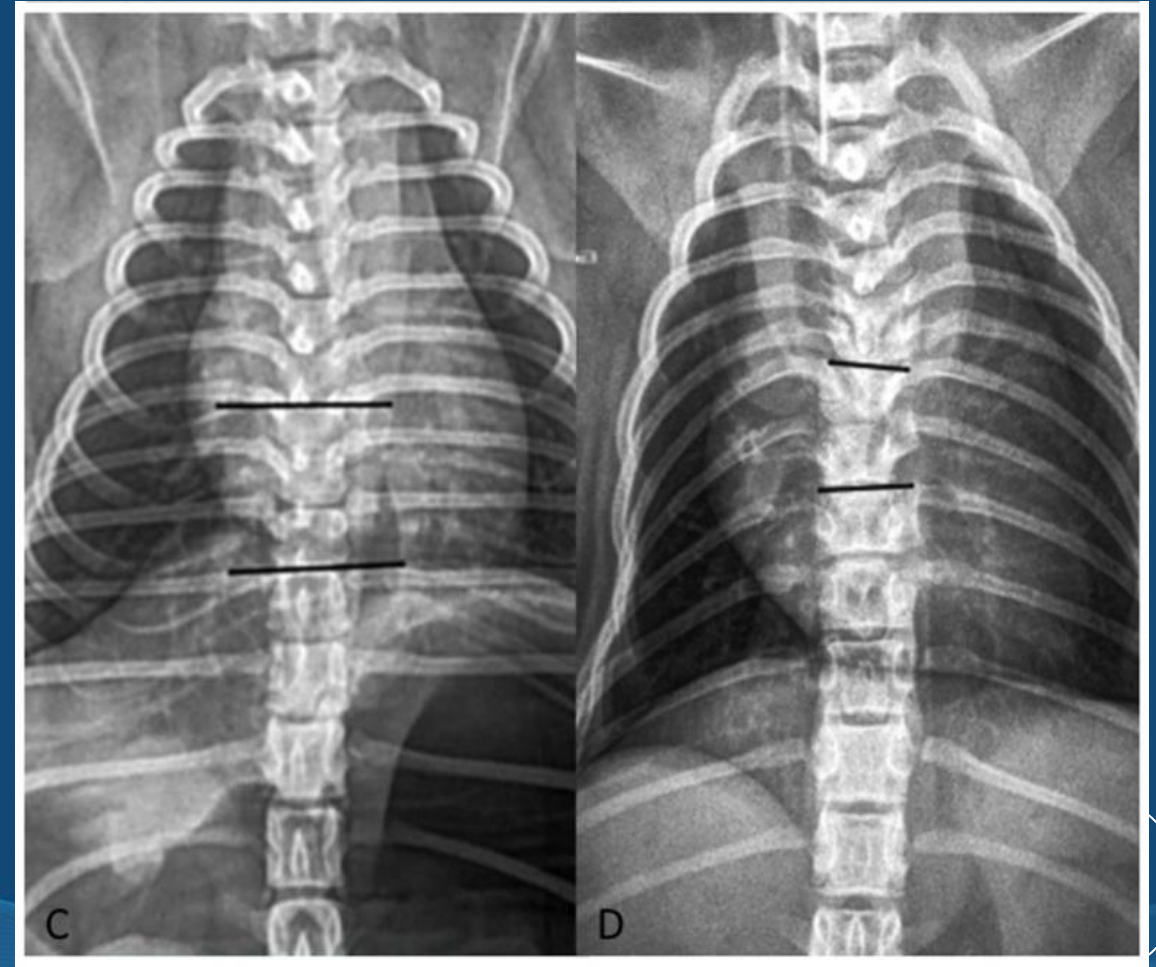
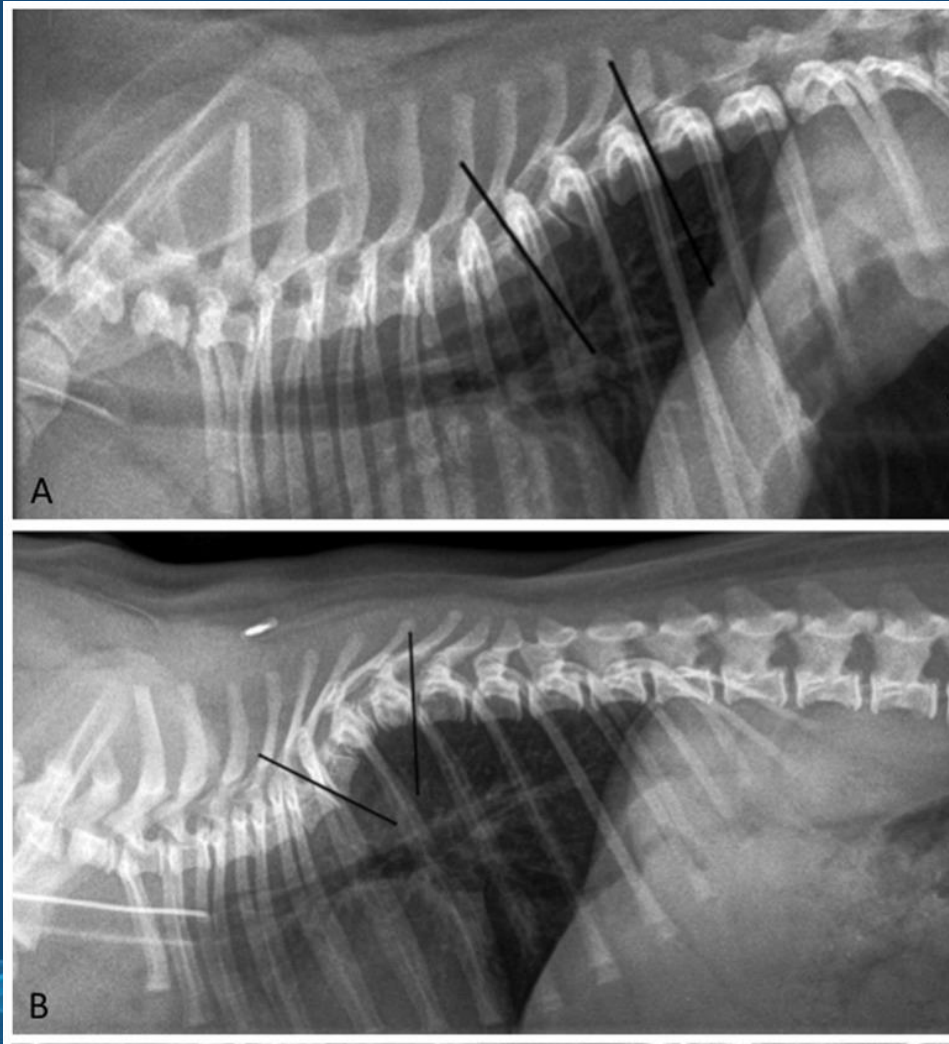
Vertebral malformations

- **Diagnostics:**
 - Screening spinal radiographs
 - Cobb angle $>35^\circ$ - increased likelihood of clinical signs



Vertebral malformations

- Cobb angle $>35^\circ$ - increased likelihood of clinical signs



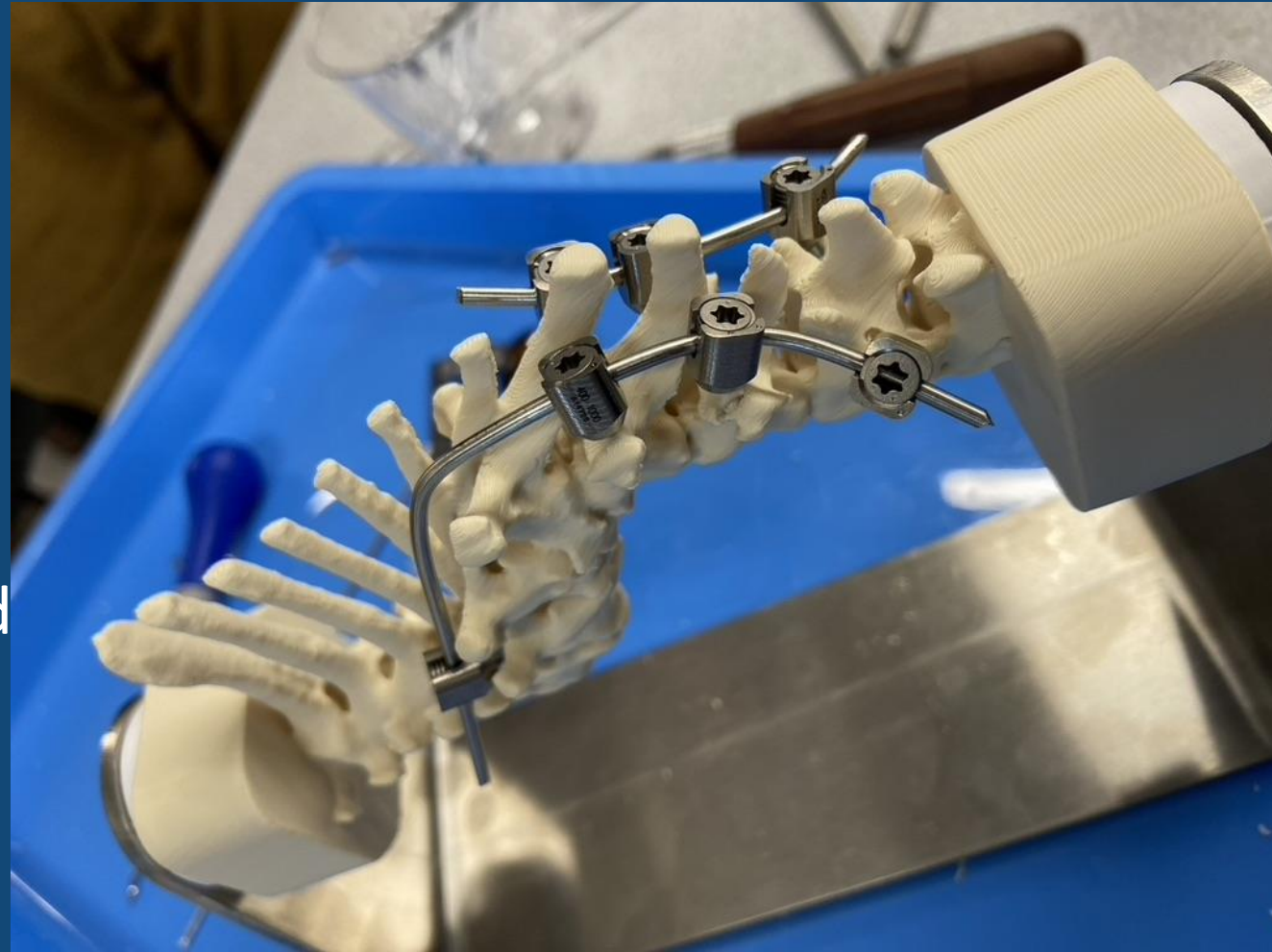
Vertebral malformations

- **Diagnostics:**
 - Screening spinal radiographs
 - Cobb angle $>35^\circ$ - increased likelihood of clinical signs
 - MRI
 - Characterization of compressive disease & spinal cord injury
 - CT
 - Characterization of osseous malformations
 - Surgical planning



Vertebral malformations

- Treatment options:
 - Surgery
 - Spinal stabilization +/- decompression
 - Medical management
 - Anti-inflammatory steroid trial



Subarachnoid diverticulum

- Compressive dilation of the subarachnoid space
- Etiology / pathogenesis not well understood
- Pugs, French bulldogs, Rottweilers over-represented
- Can occur along the cervical or thoracolumbar spine
 - 85% dogs with cervical SAD – large/giant breeds
 - 82% dogs with TL SAD – small/medium breeds



Subarachnoid diverticulum

- **Common history:**
 - Often Frenchie, Pug, Rottweilers; but can affect any breed
 - Variable age of onset
 - Slow onset, progressive paraparesis (or tetraparesis) & ataxia
 - No evidence of pain
 - +/- fecal (and/or urinary) incontinence
- **Exam findings:**
 - Varying degrees of GP ataxia > paraparesis (tetraparesis)
 - Proprioceptive deficits
 - +/- Cutaneous trunci reflex deficits
 - Lack of spinal pain

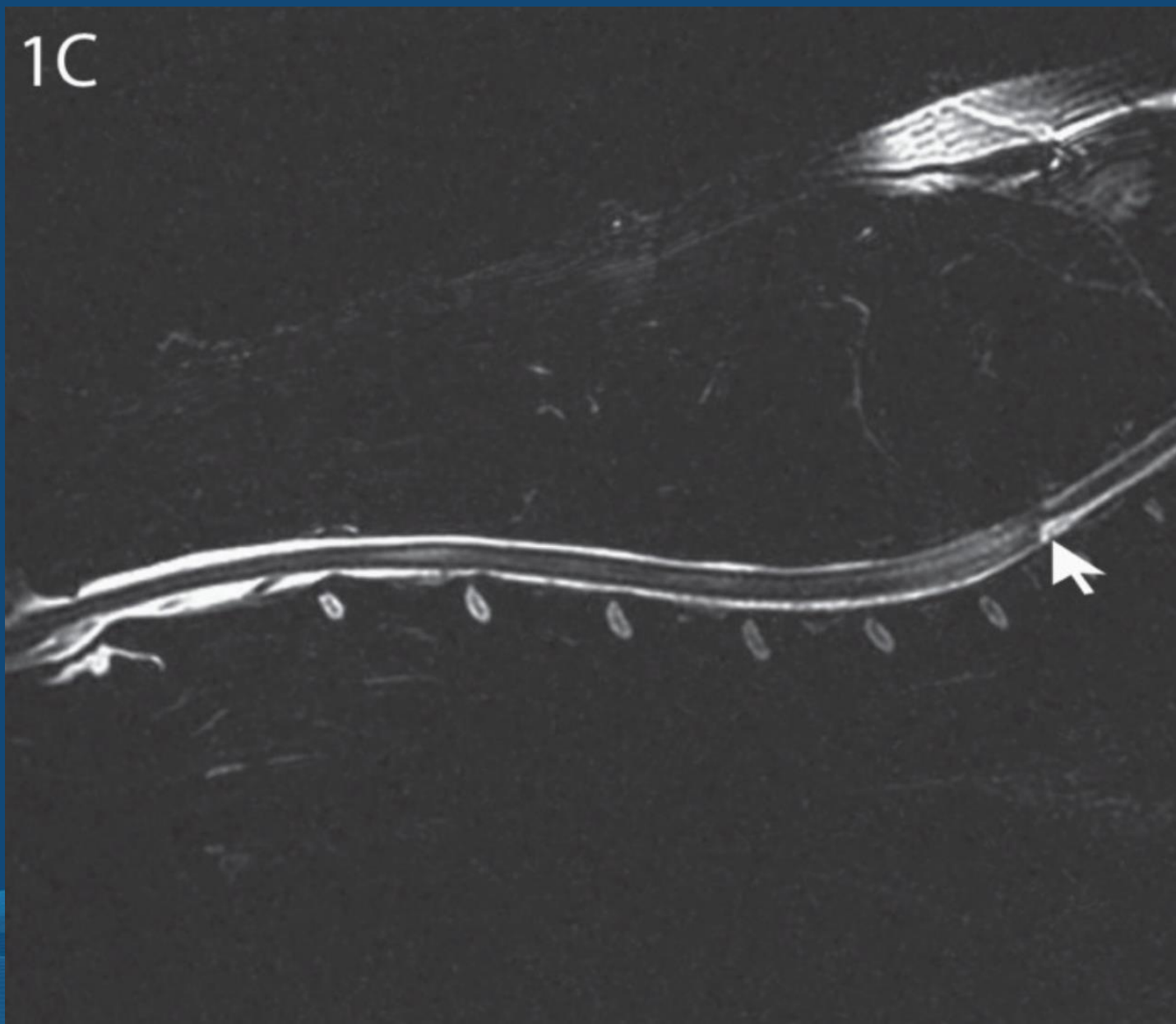


Subarachnoid diverticulum

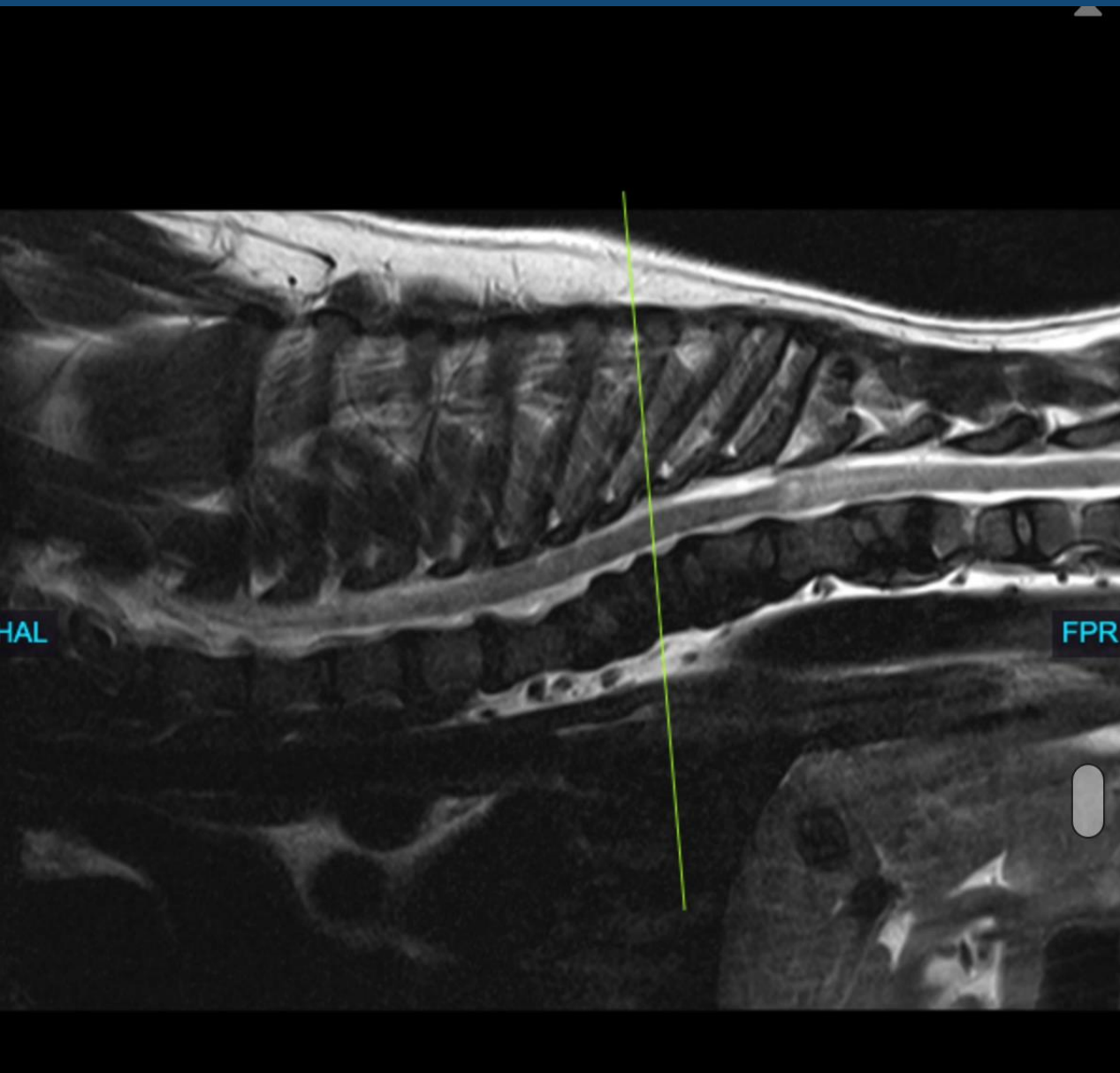
- **Diagnostics:**
 - Screening spinal radiographs
 - MRI
 - +/- CT
 - Characterization of osseous malformations
 - Surgical planning



Subarachnoid diverticulum



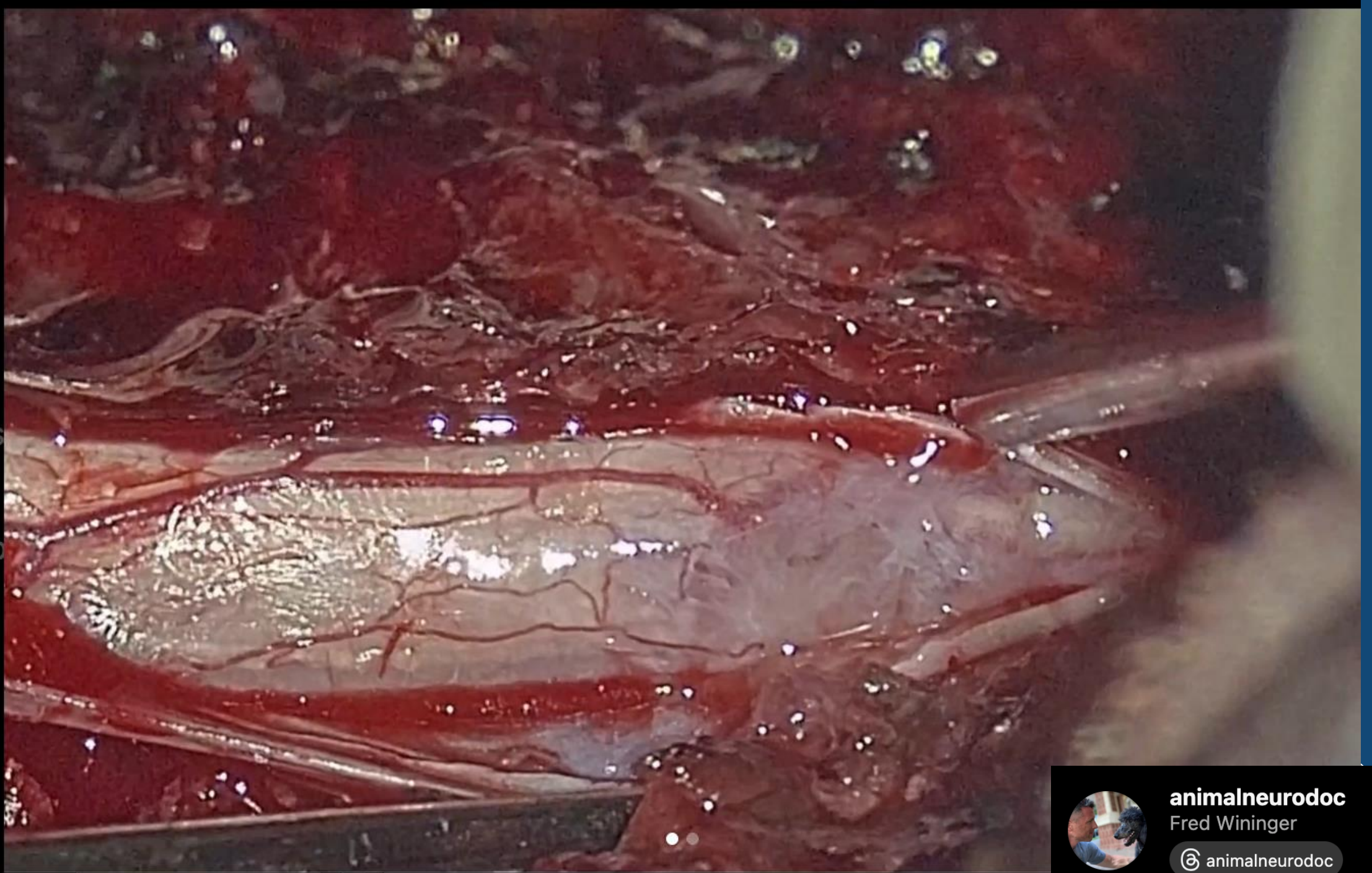
Subarachnoid diverticulum



Subarachnoid diverticulum

- Treatment options:
 - Surgery
 - Hemilaminectomy + discectomy
 - Medical management
 - Anti-inflammatory steroid trial





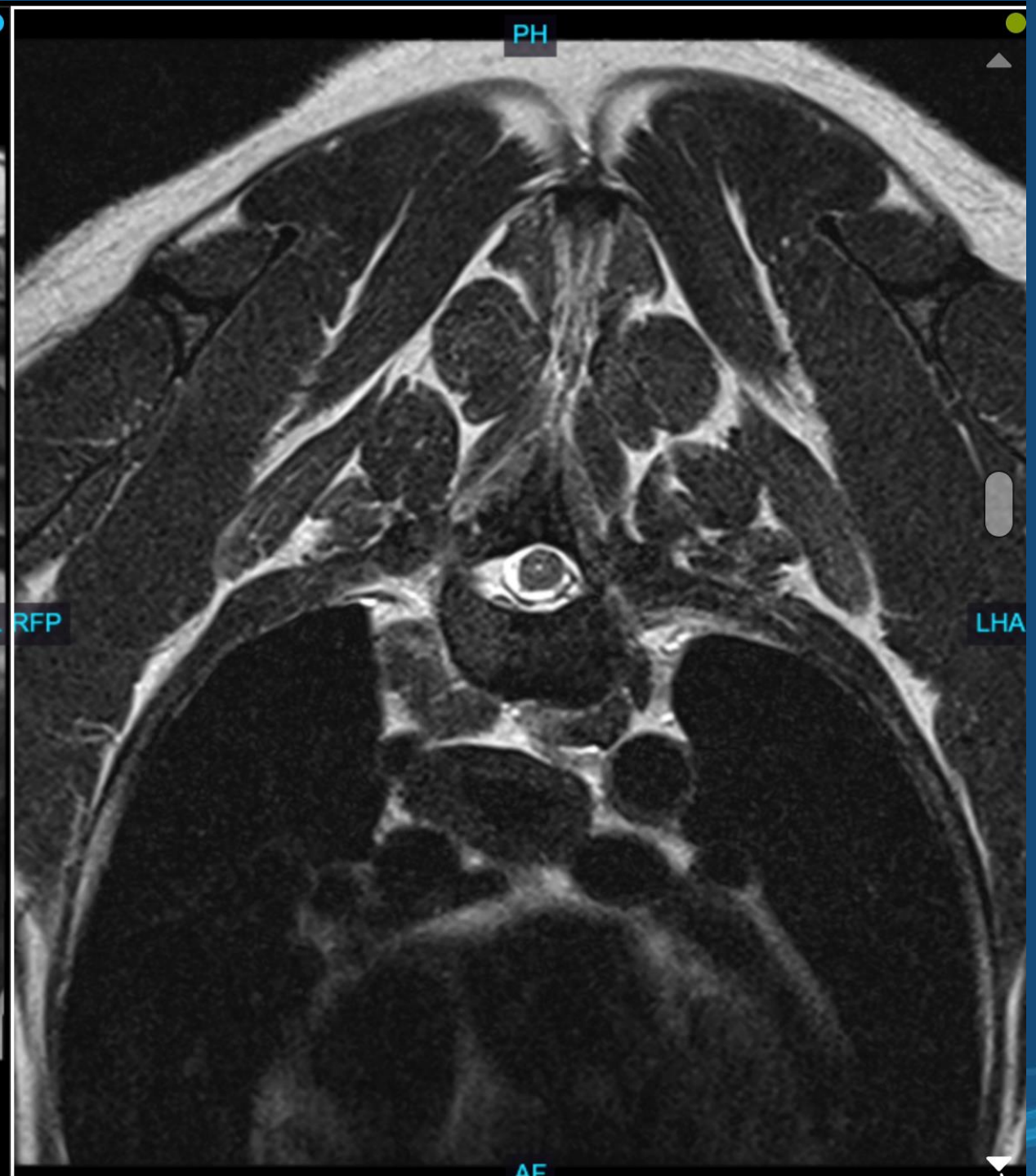
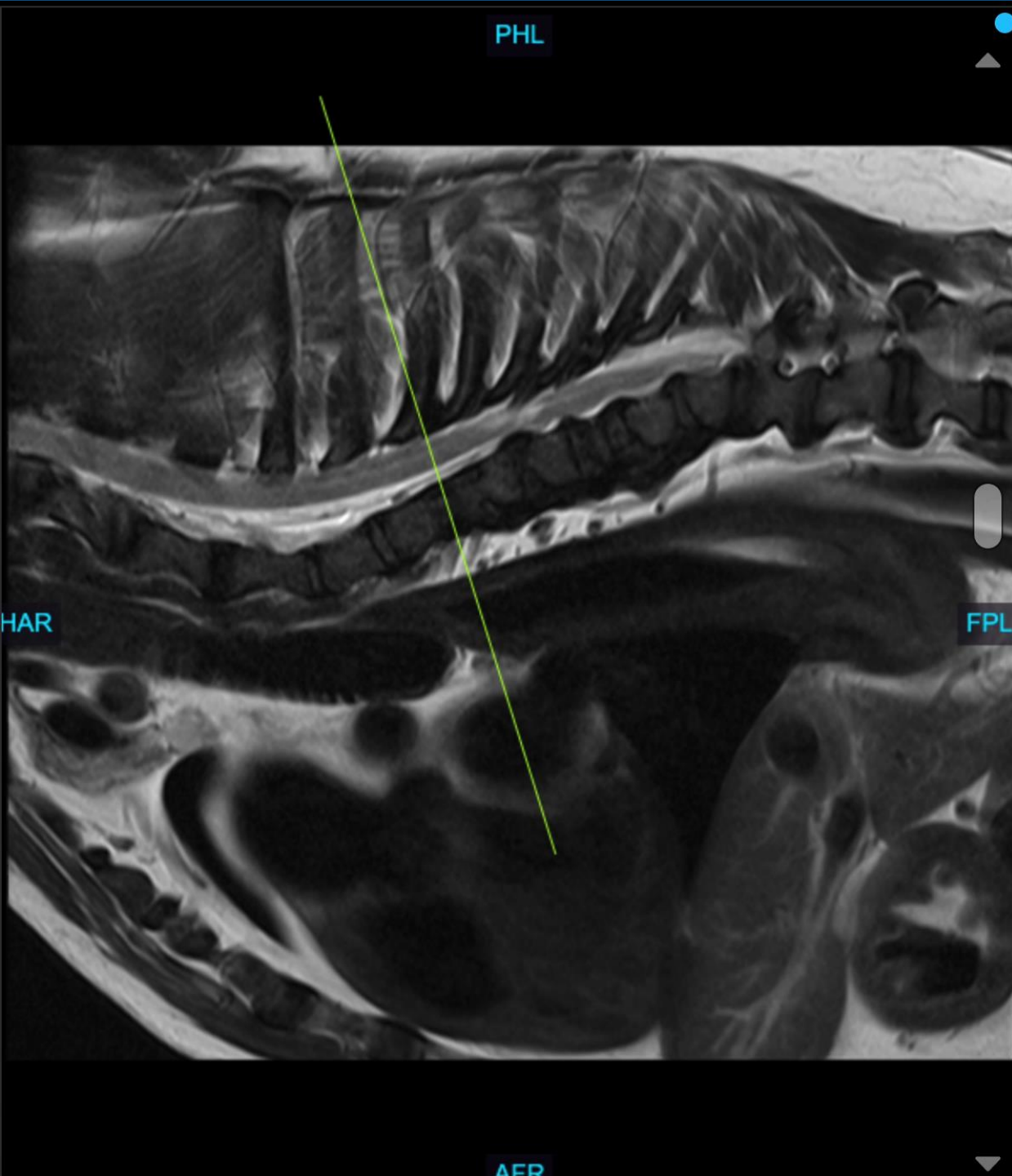
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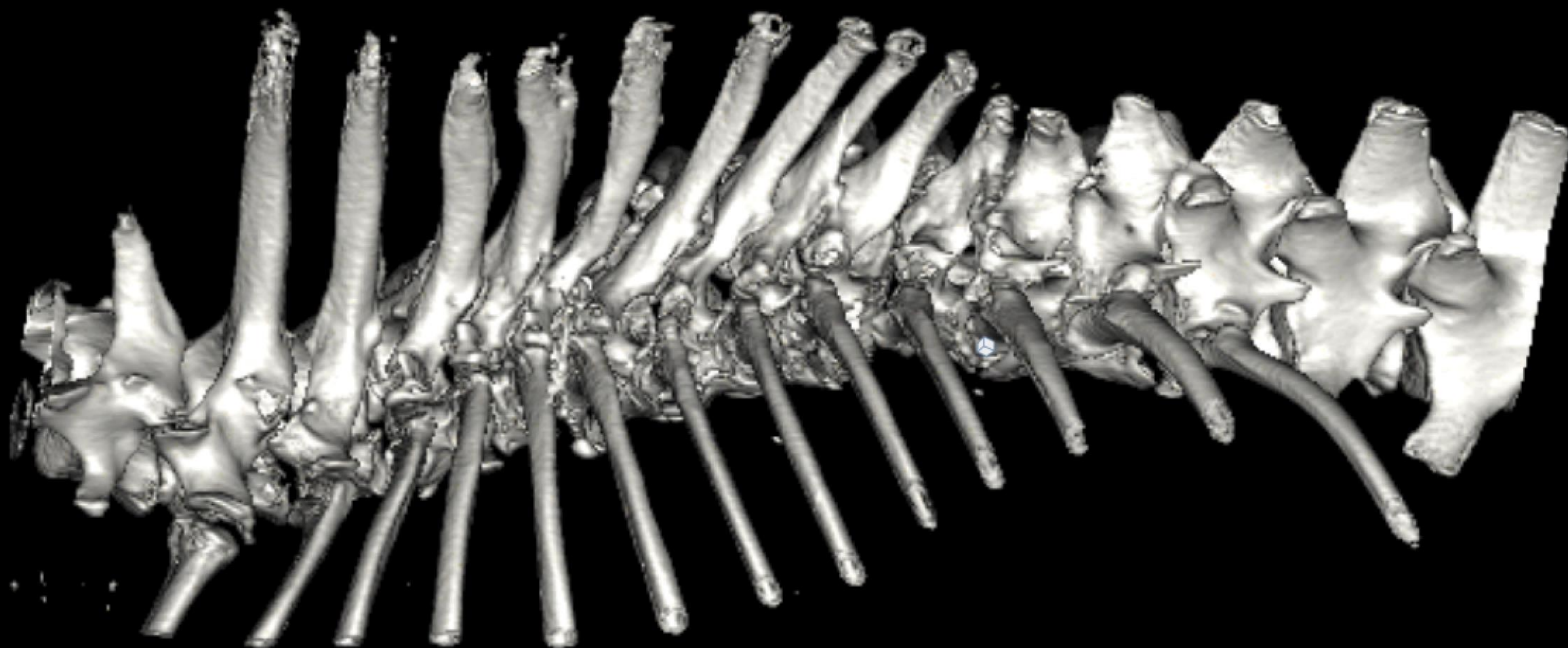
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5 yo MN French Bulldog

- **Diagnostics**
 - Thoracolumbar spine MRI + CT scan







5 yo MN French Bulldog

- **Diagnostics**

- Thoracolumbar spine MRI + CT scan

- **Treatment**

- Surgery – spinal stabilization
 - Medical management – anti-inflammatory prednisone



Case 3

Case Studies

2 month old M DSH cat

- **History:** acute onset of hind limb weakness
 - Started after a large cardboard box fell on him while playing with a housemate – afterwards immediately was having difficulty ambulating in hind limbs, hissed when palpated on hind end
 - Has been leaving small dribbles of urine around the home
 - Went to primary care veterinarian and had radiographs of pelvis / spine





2 month old M DSH cat

■ Ortho Exam Findings:

- Gait: bilateral plantigrade stance without overt lameness
- Thoracic limbs: No other joint pain, effusion, instability, or altered range of motion identified in any joint; long bones palpate normally
- Pelvic limbs: No stifle effusion or instability; no patellar luxation elicited bilaterally; common calcanean tendons palpably intact without thickening, discomfort, or atrophy; hip, tarsus, digits, and long bones palpate normally



2 month old M DSH cat

- **Neuro Exam findings:**

- Mentation: Bright, alert, responsive, feisty for handling
- Gait/posture: ambulatory with plantigrade stance in both pelvic limbs. Flaccid tail tone, no tail movement observed
- Nociception: intact in tail & perineal region
- Cranial nerves: normal
- Postural reactions: hopping mildly delayed in left pelvic limb, otherwise normal in all limbs
- Segmental reflexes/muscle tone: normal patellar reflex x 2, withdrawal reflex slightly decreased in both pelvic limbs, anal sphincter tone decreased, perineal reflex absent
- Spinal hyperesthesia: pain elicited on palpation in caudal lumbar region



2 month old M DSH cat

- What kind of weakness? Neurologic or orthopedic?

EITHER IS POSSIBLE

NEUROLOGIC

- Neurolocalization: L7-Cd (myelopathy vs. radiculopathy vs. neuropathy vs. myopathy)

ORTHOPEDIC

- Bilateral common calcanean tendon



2 month old M DSH cat

- **Differentials?**
 - Sacrocaudal luxation (tail pull injury)
 - Bilateral complete common calcanean tendon rupture
 - Caudal lumbar intervertebral disc extrusion
 - Degenerative / inflammatory neuropathy
 - Diabetic neuropathy
-



Sacrocaudal luxation

- "Tail-pull injury"
- Injury to nerve roots in the terminal spinal cord
 - Hemorrhage, edema, avulsion
- Different degrees of peripheral nerve injury
 - Neuropraxia
 - Axonotmesis
 - Neurotmesis
- Often have concurrent traumatic injuries
 - Pelvic fractures
 - Sacroiliac luxation
 - Other non-pelvic orthopedic injuries



Evaluation of prognostic factors for return of urinary and defecatory function in cats with sacrocaudal luxation

Elizabeth Couper and Steven De Decker^{ID}

Journal of Feline Medicine and Surgery
2020, Vol. 22(10) 928–934
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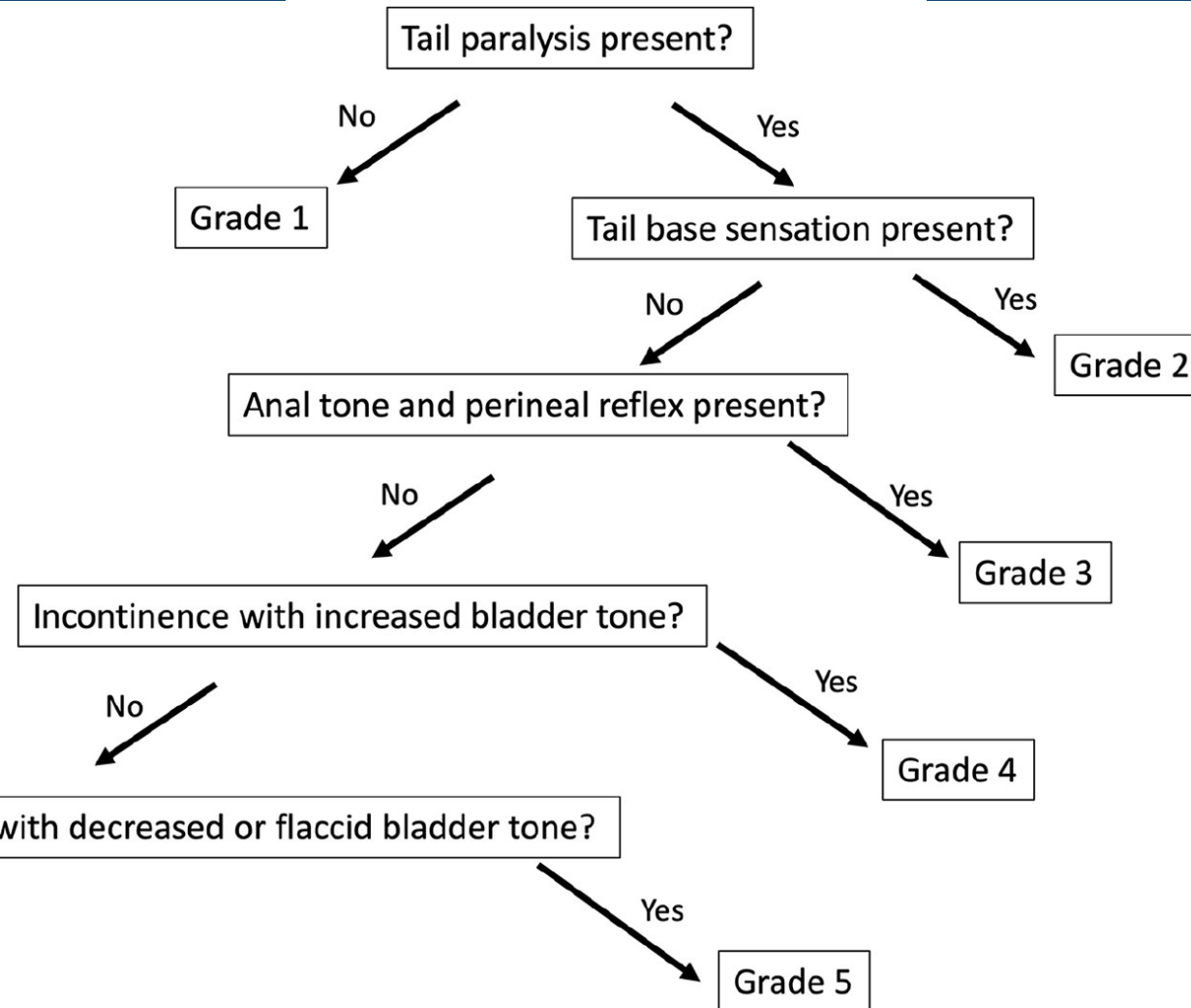


Figure 1 Flowchart demonstrating neurological grading in cats with sacrocaudal luxation

Recovery of urinary continence by neurologic grade:

- Grade 1: 100% (0d)
- Grade 2: 100% (4d)
- Grade 3: 95% (2d)
- Grade 4: 89% (12d)
- Grade 5: 50% (33d)



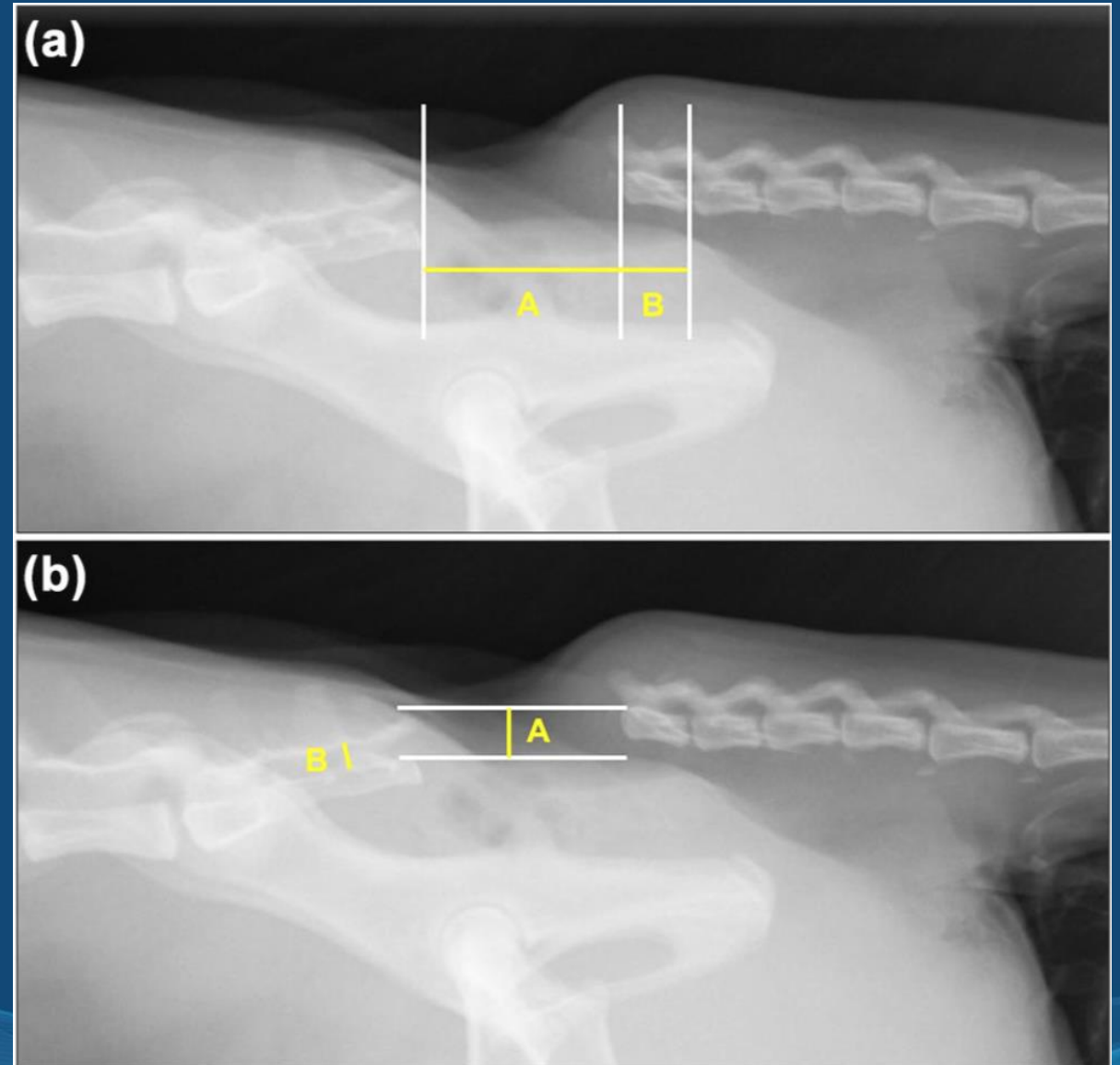
Sacrocaudal luxation

- **Common history:**
 - Traumatic injury involving traction on the tail
 - Tail caught under motor vehicle wheel, in recliner chair...etc
- **Exam findings:**
 - Paraparesis or plantigrade stance/gait
 - Tail paralysis +/- loss of nociception
 - +/- loss of anal tone & perineal nociception
 - Urinary / fecal incontinence
 - Large, soft bladder on palpation that is easily expressible



Sacrocaudal luxation

- **Diagnostics:**
 - Radiographs (pelvis, tail, pelvic limbs)



Sacrocaudal luxation

- **Treatment options:**
 - +/- Tail amputation
 - Bladder care
 - Manual expression
 - Intermittent catheterization
 - In-dwelling catheterization
 - Urinary medications
 - Prazosin
 - Bethanechol



Common Calcanean Tendon Injury

- **Common history:**
 - Acute onset of lameness
 - History of sharp or blunt trauma/laceration
 - Labs/Dobermans, older female cats – degenerative tendinopathy
- **Exam findings:**
 - Claw stance – partial tear (gastrocnemius only)
 - Plantigrade stance – complete rupture (all components)
 - +/- skin laceration
 - Palpable defects/thickenings of tendon



Common Calcanean Tendon Injury

- **Diagnostics:**
 - Ultrasound/MRI
 - Radiographs
- **Treatment Options:**
 - Conservative management
 - Orthotic/cast to immobilize tarsus in extension
 - Orthobiologics?
 - Primary tendon repair
 - Tendon transposition, allograft, synthetic mesh/grafts
 - Postoperative immobilization



2 month old M DSH cat

- **Diagnostics**

- Screening lab work (CBC/chemistry/UA)
 - Fructosamine
- Screening radiographs to rule out osseous pathology (e.g. osseous traumatic injury, osseous neoplasm)



2 month old M DSH cat



2 month old M DSH cat



2 month old M DSH cat

- **Treatment**

- Medical management – anti-inflammatory & analgesic medications
- Surgery – spinal stabilization, if indicated



Case 4

Case Studies

7 yo MN Shiba Inu

- **History:** left forelimb lameness and progressive hind limb ataxia
 - Started limping on left front leg 2-3 weeks ago; was taken to primary care veterinarian and started on carprofen
 - Limp has been improving, but he is now weaker in his hind limbs
 - Not perceived to be painful by his owners





7 yo MN Shiba Inu

■ Ortho Exam Findings:

- Gait: Mild left forelimb lameness at a walk
- Thoracic limbs: No joint pain, effusion, instability, or altered range of motion identified in any joint; long bones palpate normally
- Pelvic limbs: Slightly reduced hip extension bilaterally with normal abduction; no stifle effusion or instability; no patellar luxation elicited bilaterally; tarsus, digits, and long bones palpate normally; no overt pain on direct iliopsoas palpation



7 yo MN Shiba Inu

■ Neuro Exam findings:

- Mentation: Bright, alert, responsive
- Gait/posture: ambulatory with mild left thoracic limb lameness, mild-moderate UMN/GP paraparesis/ataxia in pelvic limbs. Subjectively stiff/low head carriage
- Cranial nerves: normal
- Postural reactions: delayed paw placement & hopping in the pelvic limbs, left worse than right. Mild delay in paw placement & hopping in left thoracic limb
- Segmental reflexes/muscle tone: decreased tone of the left thoracic limb. Normal patellar x 2, normal withdrawal x 4, CT reflex normal, perineal reflex normal
- Spinal hyperesthesia: resistant on cervical range of motion, especially with ventral flexion. Otherwise no overt pain elicited on palpation



7 yo MN Shiba Inu

- What kind of weakness? Neurologic or orthopedic?

NEUROLOGIC

- Neurolocalization: C6-T2 myelopathy

Less likely to be concurrent neurologic + orthopedic...

- T3-L3 myelopathy + forelimb lameness (elbow, biceps brachii)



7 yo MN Shiba Inu

■ Differentials?

ORTHOPEDIC

- Elbow dysplasia
- Biceps brachii tenosynovitis

NEUROLOGIC

- Intervertebral disc protrusion
- Caudal cervical spondylomyelopathy
- Neoplasia



Caudal cervical spondylomyelopathy

“Wobbler’s syndrome”

- **Disc-associated**
 - Middle-aged large breed dogs
 - Doberman
 - Disc protrusion +/- ligamentous hypertrophy & congenital vertebral canal stenosis
 - Most common at C5-C6 & C6-C7
 - ~50% dogs can have multiple sites of compression
- **Osseous-associated**



Caudal cervical spondylomyelopathy

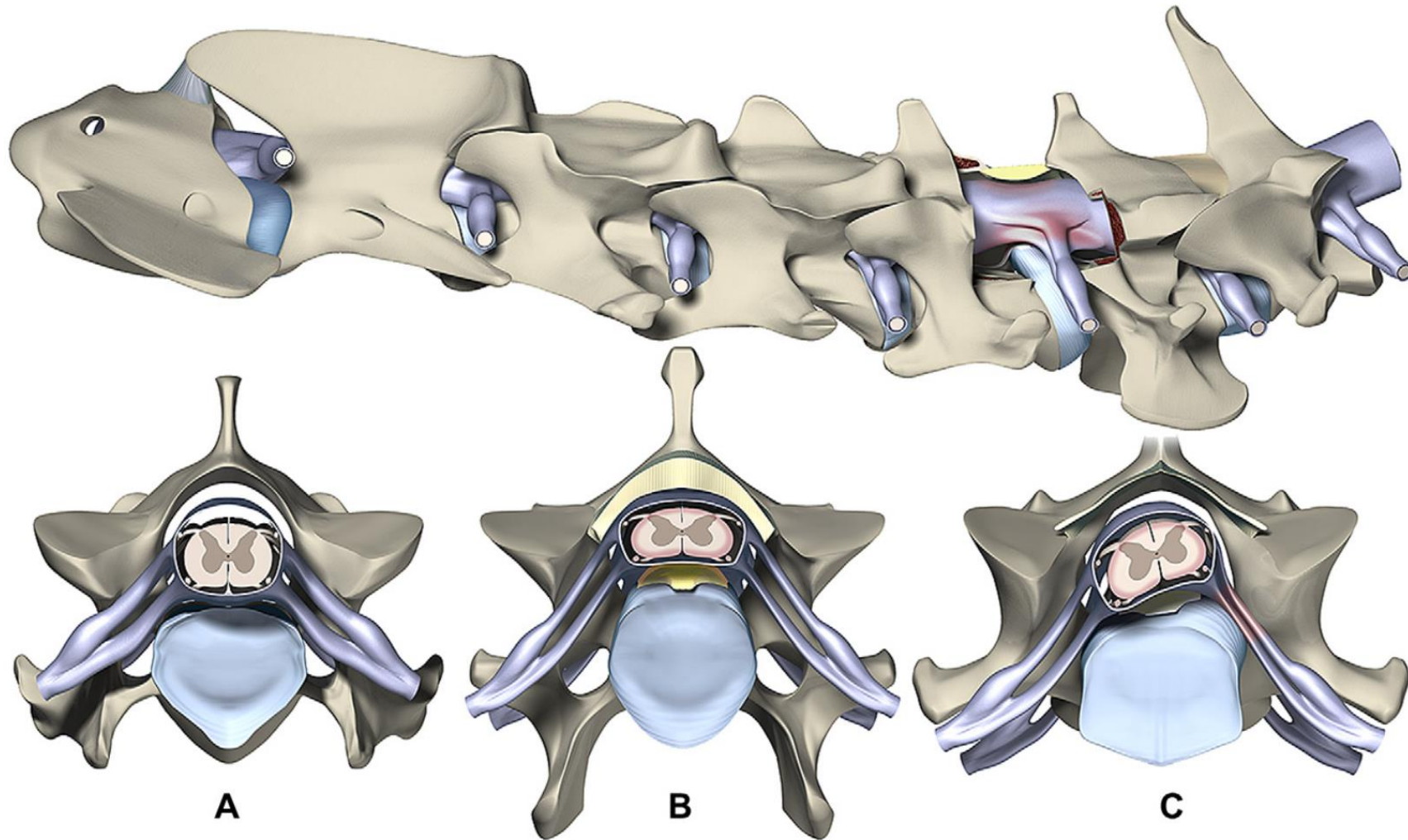


Fig. 1. Disc-associated CSM. (*Top*) Ventral spinal cord compression and nerve root compression at C5-6 caused by intervertebral disc protrusion. Dorsally, hypertrophy of the ligamentum flavum causes mild spinal cord compression. (*Bottom*) (A) Transverse section at the level of the C4-5 disc region showing normal spinal cord and vertebral canal. (B) Ventral compression at C5-6 region caused by intervertebral disc protrusion and hypertrophy of the dorsal longitudinal ligament (yellow) and ligamentum flavum (causing mild dorsal compression). (C) Asymmetric intervertebral disc protrusion at C6-7 causing spinal cord and nerve root compressions. (Courtesy of The Ohio State University; with permission.)



Caudal cervical spondylomyelopathy

“Wobbler’s syndrome”

- **Disc-associated**
 - Middle-aged large breed dogs
 - Doberman
 - Disc protrusion +/- ligamentous hypertrophy & congenital vertebral canal stenosis
 - Most common at C5-C6 & C6-C7
 - ~50% dogs can have multiple sites of compression
- **Osseous-associated**
 - Young giant breed dogs
 - Osseous proliferation of dorsolateral components of the vertebral canal
 - Vertebral malformations
 - Osteoarthritic changes
 - ~80% dogs can have multiple sites of compression



Caudal cervical spondylomyelopathy

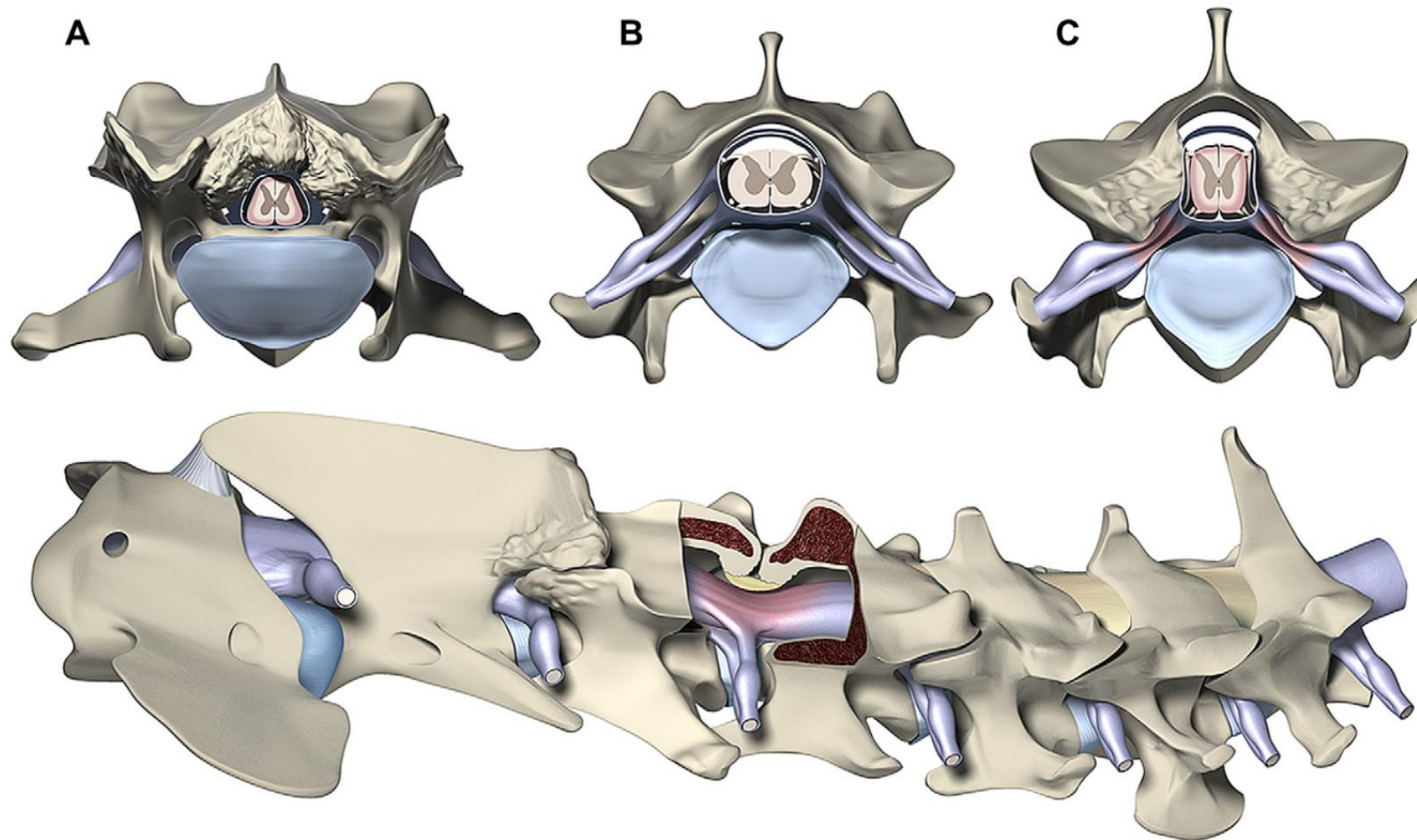


Fig. 2. Osseous-associated CSM. (Top) (A) Severe dorsolateral spinal cord compression at C2-3 caused by osseous malformation and osteoarthritic changes. (B) Normal C3-4 disc region. (C) Bilateral compression at C4-5 caused by osteoarthritic changes and medial proliferation of the facets causing absolute vertebral canal stenosis and foraminal stenosis, leading to spinal cord and nerve root compressions, respectively. (Bottom) Dorsal spinal cord compression at C3-4 caused by lamina malformation and hypertrophy of the ligamentum flavum. Osteoarthritic changes are also shown at C2-3. (Courtesy of The Ohio State University; with permission.)



Caudal cervical spondylomyelopathy

- **Common history:**

- Chronic progressive tetraparesis (or paraparesis) & ataxia; sometimes acute-on-chronic scenario
- +/- evident cervical pain

- **Exam findings:**

- Varying degrees of tetraparesis & GP ataxia
 - Thoracic limbs can be either UMN or LMN quality paresis
 - Pelvic limbs UMN quality paresis
- Often low or stiff head carriage
- Proprioceptive deficits
 - Pelvic limbs +/- thoracic limbs
- +/- withdrawal reflex deficits in thoracic limbs
- Decreased cervical ROM +/- overt cervical pain







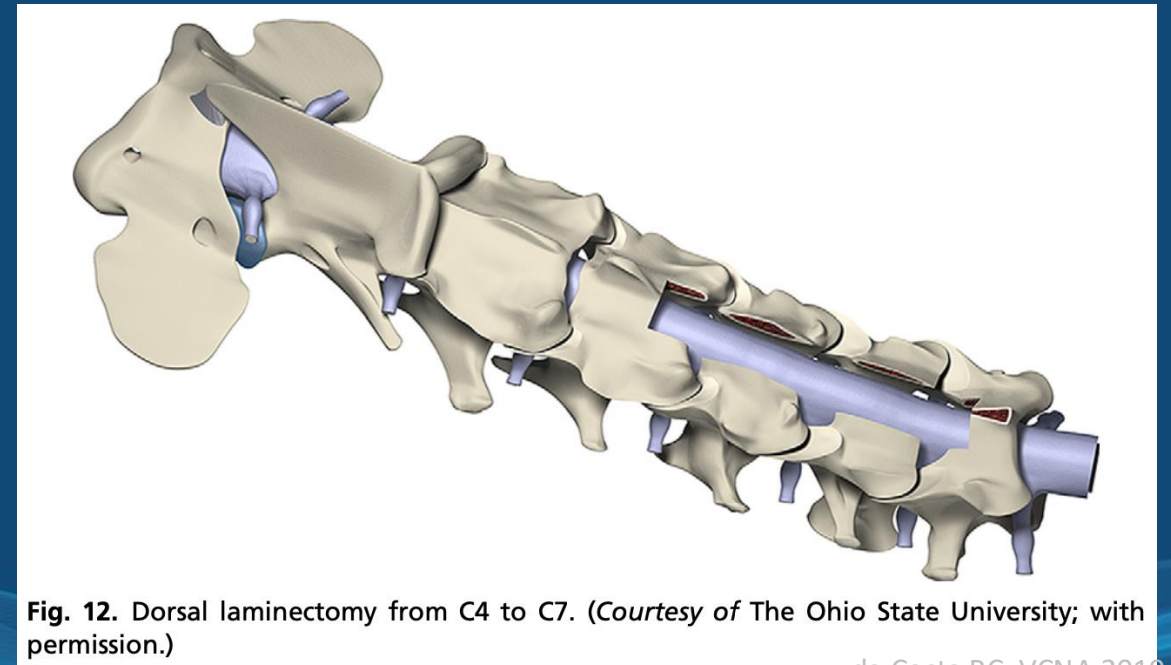
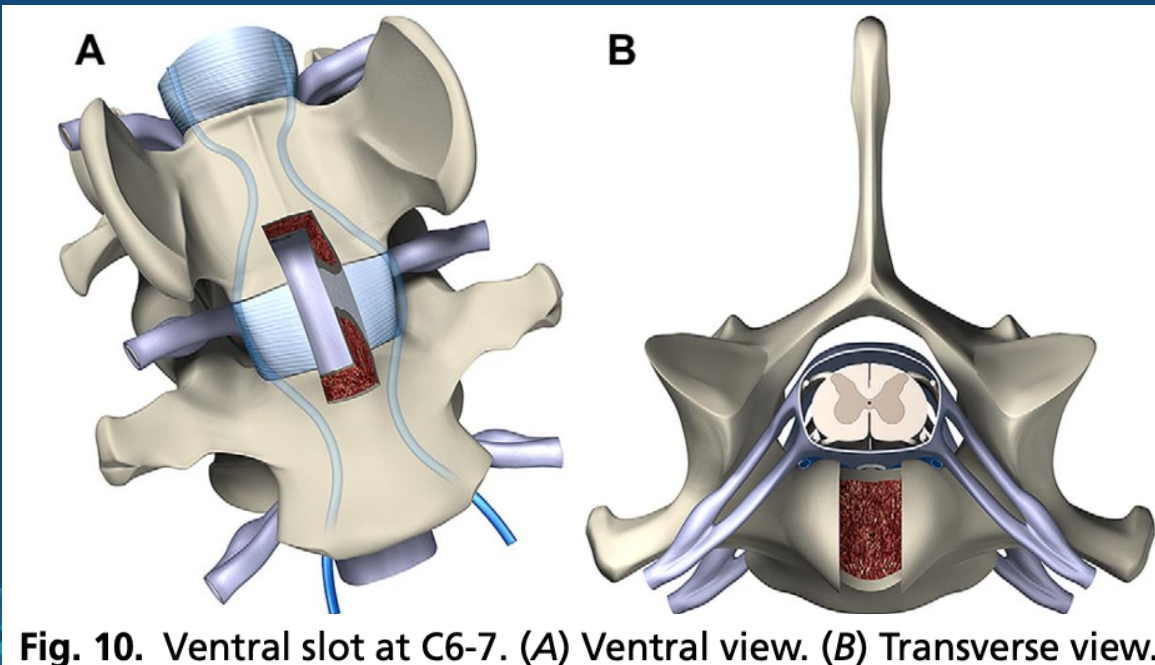
Caudal cervical spondylomyelopathy

- **Diagnostics:**
 - Spinal radiographs
 - MRI
 - +/- CT
 - Characterization of osseous malformations
 - Surgical planning
- Peri-anesthetic & pre-surgical considerations (Doberman)
 - Echocardiogram, ECG
 - vWD genetic test
 - Buccal mucosal bleeding time (BMBT)



Caudal cervical spondylomyelopathy

- Treatment options:
 - Surgery
 - Ventral slot
 - Decompressive dorsal laminectomy vs. hemilaminectomy
 - Discectomy + distraction / stabilization



Caudal cervical spondylomyelopathy

- Treatment options:

- Surgery

- Ventral slot
 - Decompressive dorsal laminectomy vs. hemilaminectomy
 - Discectomy + distraction / stabilization

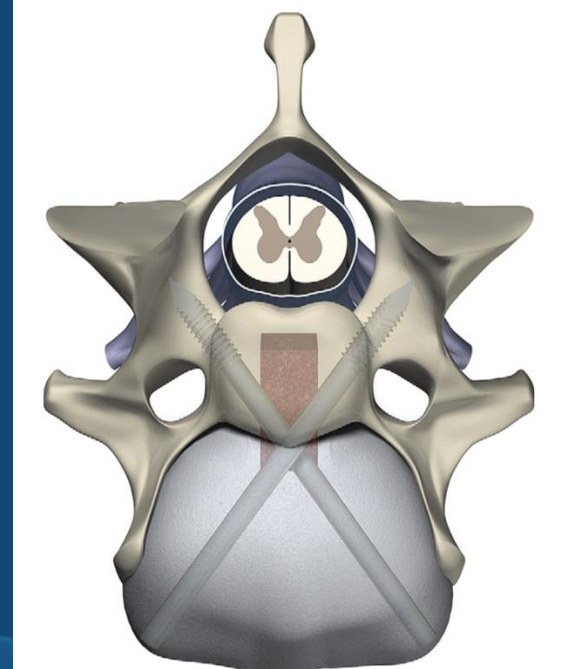
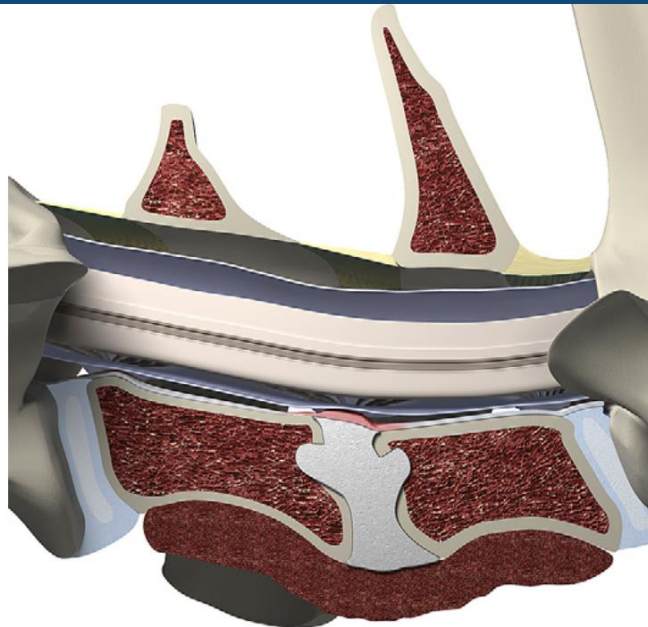


Fig. 14. The PMMA plug distraction technique. The PMMA plug is in place (*gray*). Two



Caudal cervical spondylomyelopathy

- Treatment options:
 - Surgery
 - Ventral slot
 - Decompressive dorsal laminectomy vs. hemilaminectomy
 - Discectomy + distraction / stabilization
 - Medical management
 - Anti-inflammatory steroid trial
 - Strict rest
 - Especially minimize impact to thoracic limbs (e.g. jumping out of car or down from furniture)
 - Physical therapy



7 yo MN Shiba Inu

- **Diagnostics**
 - Spinal radiographs (cervical, thoracolumbar)



Spinal radiographs – positioning is key

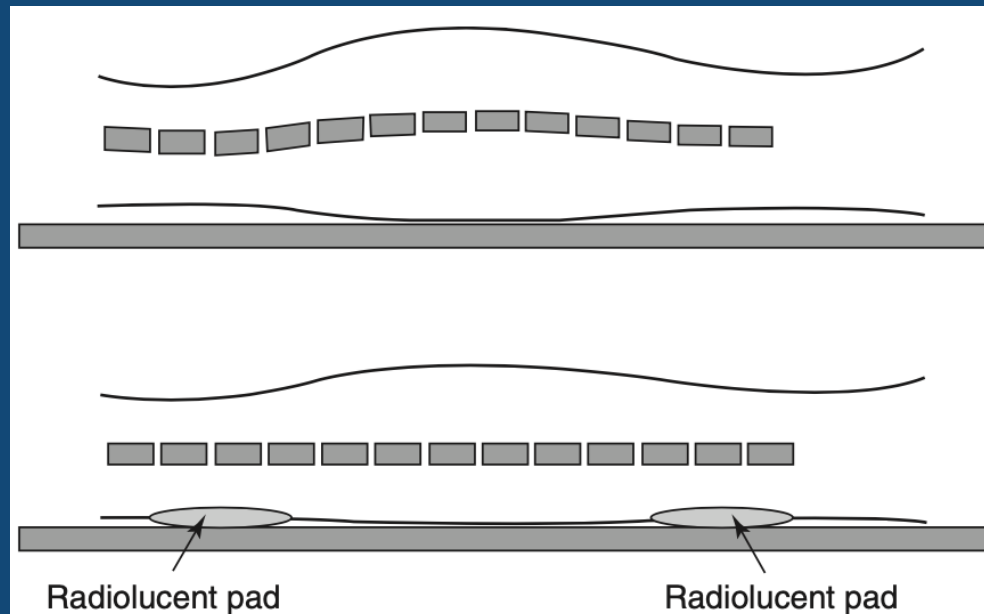


Fig. 7-20 Diagram illustrating the use of nonradiopaque pads for lateral spinal radiographs. Elevation of dependent portions of the vertebral column leads to improved vertebral alignment. The perspective of the image is as if the viewer is looking at the dorsal aspect of a dog while it is lying on the x-ray table. In the *top panel*, the dog is allowed to lie unrestrained on the table. The natural curve of the body will result in the vertebrae not being aligned in one plane. In this instance, the varying relation of the vertebrae with the primary x-ray beam will lead to distortion. In the *bottom panel*, dependent (sagging) portions of the vertebrae are elevated with nonradiopaque pads, which results in all vertebrae being more aligned in a plane parallel with the top of the x-ray table. This maneuver will lead to a less distorted lateral projection of the vertebrae. (Reprinted with permission from Thrall DE, Robertson ID: *Atlas of normal radiographic anatomy and anatomic variants in the dog and cat*, St Louis, 2011, Elsevier-Saunders.)



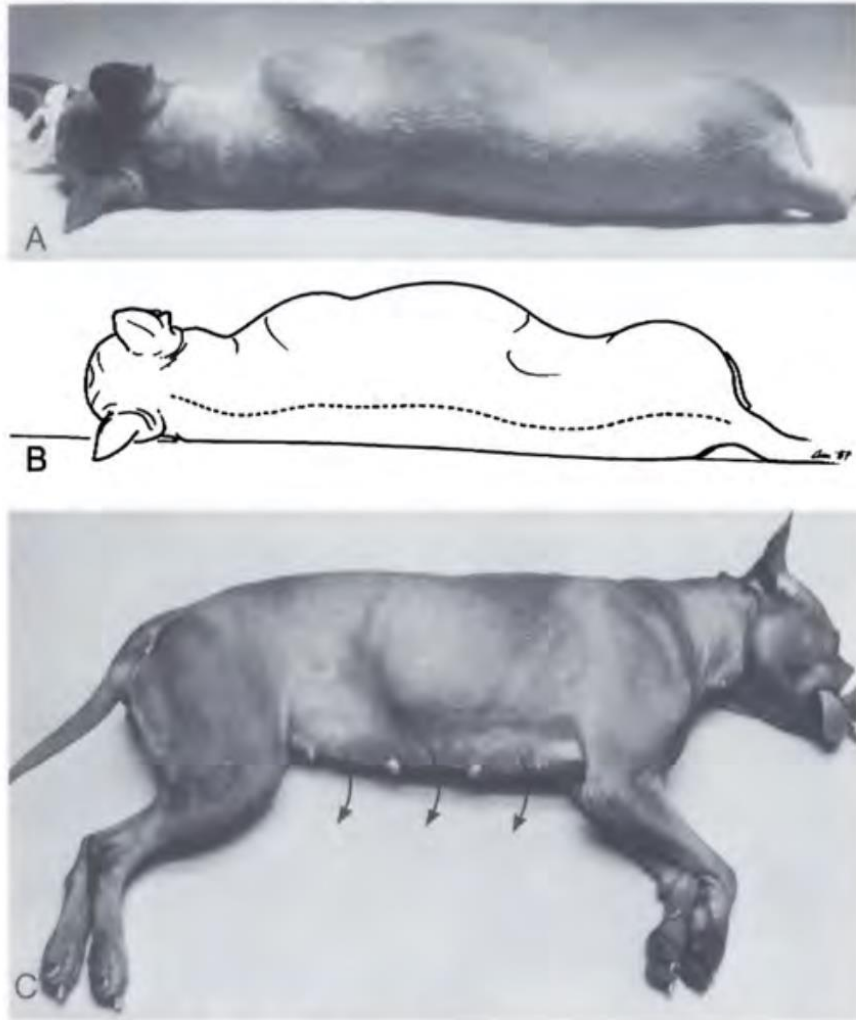


Figure 5. A view of the back of a dog lying in lateral recumbency (A) demonstrates the scoliotic position (B) the spinal column assumes if padding is not used to keep the entire spine parallel to the tabletop. If padding is not placed under the sternum and between the limbs, axial rotation occurs as the sternum and upper limbs roll down toward the tabletop (C).

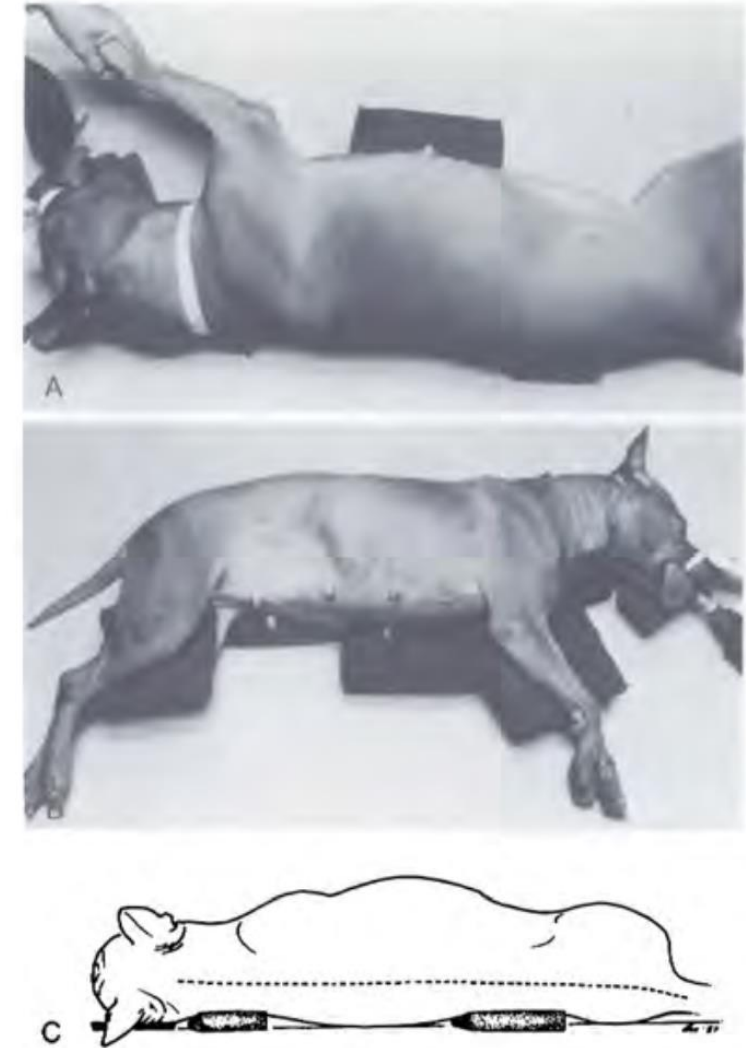


Figure 8. Proper lateral positioning for thoracic, lumbar, sacral, and coccygeal vertebrae requires foam padding to prevent scoliotic sagging and axial rotation (A, B, and C). The cervical spine should also be supported to maintain proper positioning of the upper thoracic vertebrae.

Spinal radiographs – positioning is key

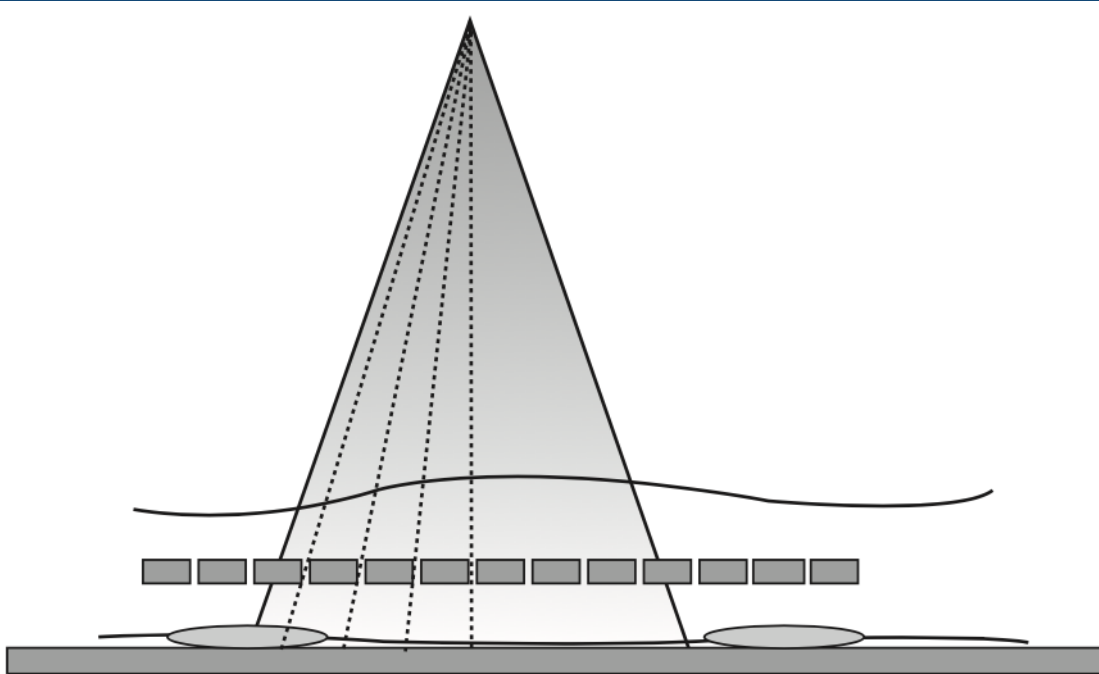


Fig. 7-21 Diagram illustrating the effect of divergence of the x-ray beam on disk-space width. The *gray triangle* represents the diverging x-ray beam. The *dotted lines* represent x-ray photons that will strike four adjacent intervertebral disk spaces. The vertical photon will pass through the central disk space, and the image will be representative of the actual size of the disk space. As one proceeds further peripherally from this central photon to the reader's left, the relationship of the photon with the disk space becomes less aligned, and this will lead to an image of the disk space that is narrower than its actual width and not representative of the true size of the disk space. (Reprinted with permission from Thrall DE, Robertson ID: *Atlas of normal radiographic anatomy and anatomic variants in the dog and cat*, St Louis, 2011, Elsevier-Saunders.)

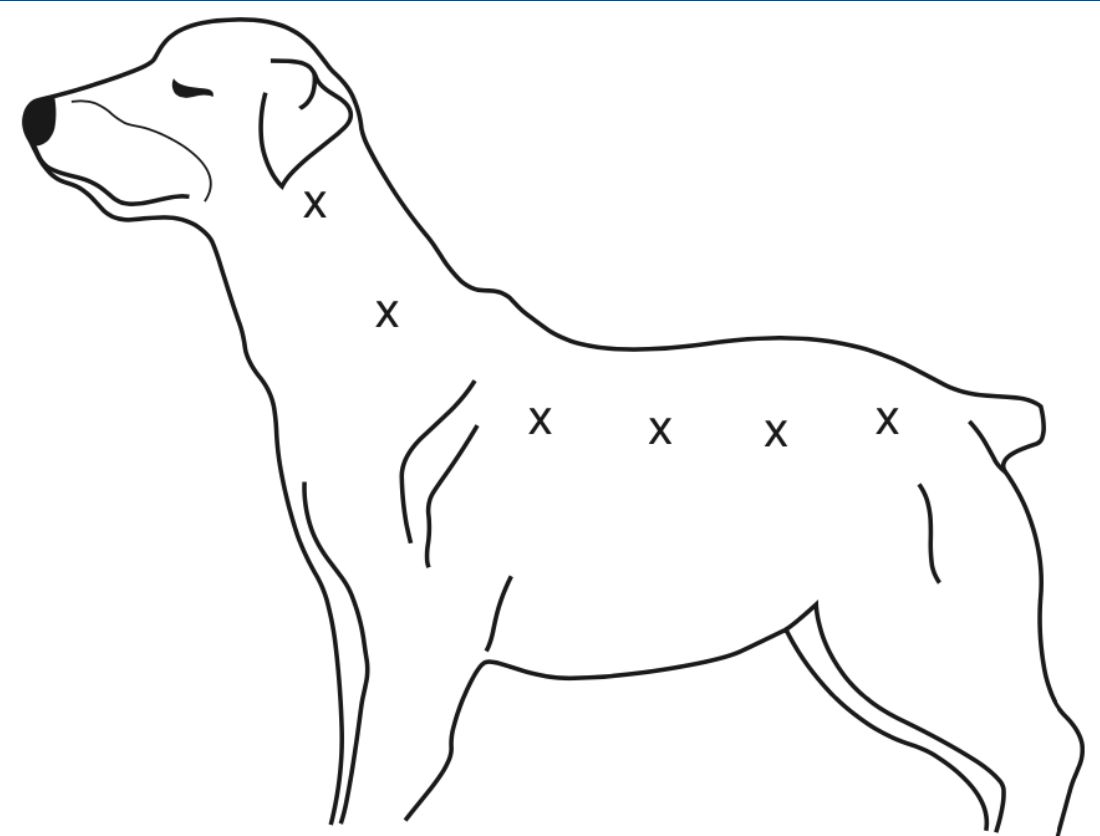


Fig. 7-22 Illustration of the centering points, designated by X, needed to obtain a lateral survey radiographic study of the entire spine. Lateral views centered approximately at C2, C7, T4, T13, L3, and L7 will be needed to obtain radiographs that depict spinal anatomy throughout the length of the spine without distortion. In very small subjects this number of projections may be reduced proportionally, but in medium or large subjects this number of views will be needed. The same centering points should be used for VD survey radiographs.

Spinal radiographs – positioning is key

- Get sternum & spine in the same plane using foam pads/blocks (radiolucent material)
 - Usually via lifting the sternum; in some patients with rounded thorax, may require displacing sternum toward the table
- Use foam pads/blocks to eliminate sagging or undulation of the spine parallel to the table
 - Usually via lifting immediately cranially to the shoulders and immediately cranially to the hips
- Take a series with different centering points to reduce distortion at the image periphery – both lateral & VD
 - Cranial cervical – *pull legs back*
 - Caudal cervical – *pull legs forward*
 - Thoracic
 - Thoracolumbar junction
 - Lumbar
 - Lumbosacral junction

*If a spinal
trauma suspect
– skip the VD*



Spinal radiographs – positioning is key

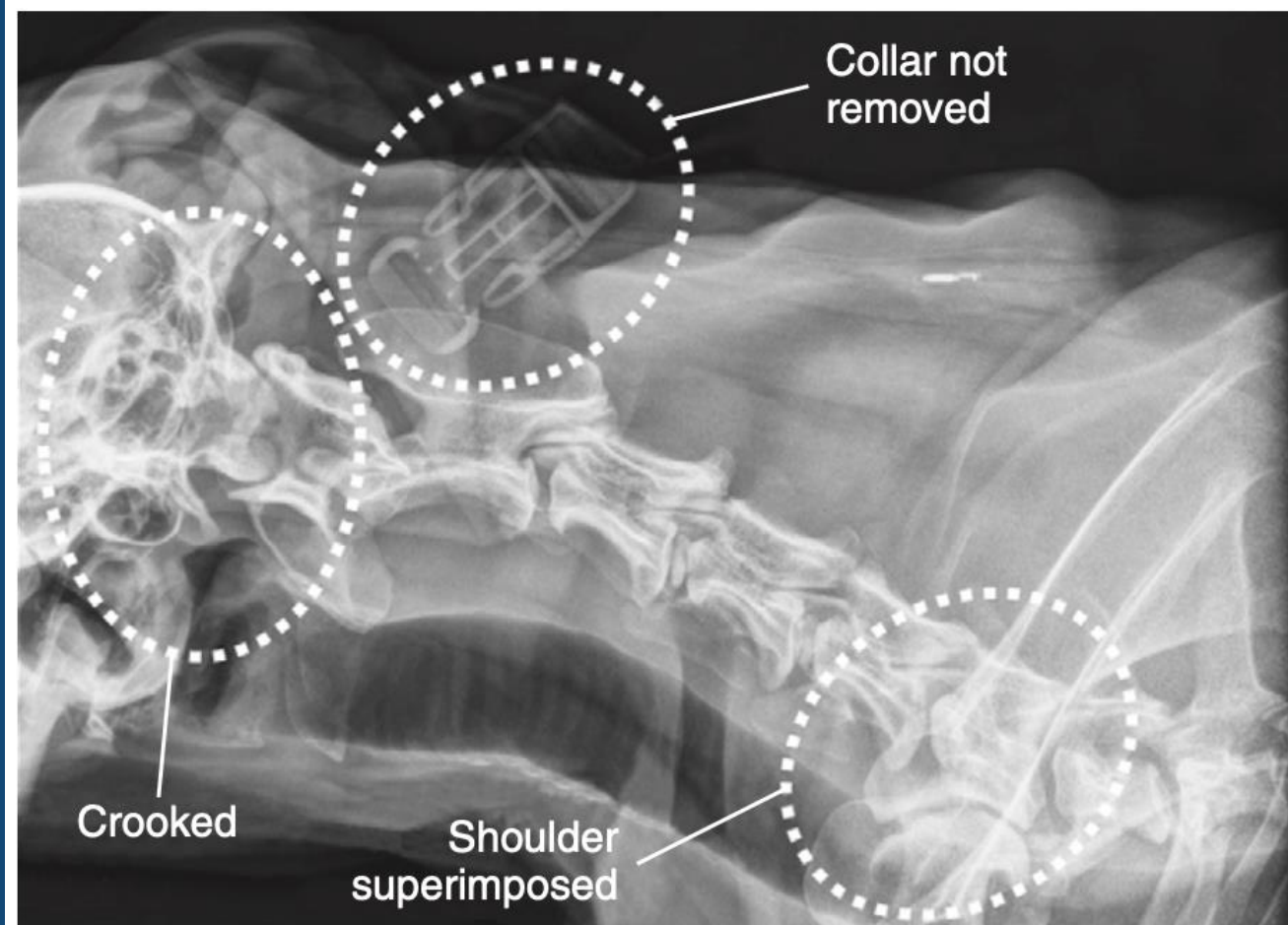


Fig. 7-18 A poorly positioned cervical radiograph that is totally useless. The patient is crooked, the collar has not been removed, and a shoulder is superimposed on the caudal aspect of the cervical spine. This is a careless approach that wastes time and needlessly increases personnel radiation exposure. The patient and owner deserve higher-quality work.



7 yo MN Shiba Inu

- **Diagnostics**

- Spinal radiographs (cervical, thoracolumbar)
- Cervical spine MRI

- **Treatment**

- Surgery – discectomy + spinal stabilization
- Medical management – anti-inflammatory prednisone, analgesics





Case 5

Case Studies

10 yo M German Shepherd

- **History:** 6 month history of progressive hind limb weakness, significantly more progressive over past 2 months.
 - Has progressed from stumbling in hind end to needing full support with Help'EmUp harness
 - A couple weeks ago, became acutely weak in the right forelimb and mobility was further impacted
 - Diagnosed with hip dysplasia at 1 year of age via radiographs





10 yo M German Shepherd

■ Ortho Exam Findings:

- Gait: Bilateral weightbearing pelvic limb lameness with support, grade 2 right thoracic limb lameness
- Right thoracic limb: Significant thickening of elbow with decreased flexion; no other joint pain, effusion, instability, or altered range of motion identified in any joint; long bones palpate normally; no biceps pain on direct palpation
- Left thoracic limb: No joint pain, effusion, instability, or altered range of motion identified in any joint; long bones palpate normally; no biceps pain on direct palpation
- Right pelvic limb: Decreased hip extension with creptius/discomfort on ROM; no stifle effusion or instability; tarsus, digits, and long bones palpate normally
- Left pelvic limb: Positive cranial drawer & tibial thrust, crepitus on ROM; decreased hip extension with creptius/discomfort on ROM; tarsus, digits, and long bones palpate normally



10 yo M German Shepherd

- **Neuro Exam Findings:**
- **Gait/posture:**
 - **Non-ambulatory paraparetic (vs. tri- / tetraparetic) with GP ataxia in pelvic limbs - good motor function in pelvic limbs (right worse than left), advancing both with every step.**
 - **At times appears lame in right thoracic limb – right thoracic limb (equivocally left thoracic limb as well) has appearance of spastic paresis with GP ataxia; also infrequently knuckles in right thoracic limb**
- **Postural reactions: paw placement absent in pelvic limbs and delayed in right thoracic limb, hopping delayed to absent in pelvic limbs and normal in thoracic limbs**
- **Segmental reflexes/muscle tone: normal tone in pelvic limbs, spastic tone in right thoracic limb. Withdrawal reflex apparently normal in all limbs. Cross extensor reflex present with stimulation of both pelvic limbs. Patellar reflex intact x 2. CT reflex normal.**
- **Spinal hyperesthesia: no overt pain elicited on palpation of vertebral column**



10 yo M German Shepherd

- What kind of weakness? Neurologic or orthopedic?

BOTH

- Known orthopedic disease, likely concurrent/additive paresis

ORTHOPEDIC

- Right forelimb lameness – elbow
- Bilateral hindlimb lameness – hips, iliopsoas, stifles

NEUROLOGIC

- Neurolocalization: C1-T2 myelopathy (R>L) +/- concurrent T3-L3 myelopathy



10 yo M German Shepherd

■ Differentials?

ORTHOPEDIC

- Hip dysplasia + secondary osteoarthritis
- Cranial cruciate ligament disease
- Iliopsoas injury
- Immune-mediated polyarthropathy
- Infectious arthropathy
- Neoplasia

NEUROLOGIC

- Intervertebral disc protrusion
- Degenerative myelopathy
- Caudal cervical spondylomyelopathy
- Neoplasia



Hip Dysplasia

- **Common history:**

- Bunny-hopping as a puppy, progressing to stiffness after rest, exercise intolerance
- Less willing to jump up or climb stairs
- Improves with rest/NSAIDs
- Rarely associated with acute lameness/progression

- **Exam findings:**

- Decreased hip extension & abduction
- Positive Ortolani test
- Crepitus on ROM
- Tarsal hyperextension
- Concurrent iliopsoas strain in advanced cases



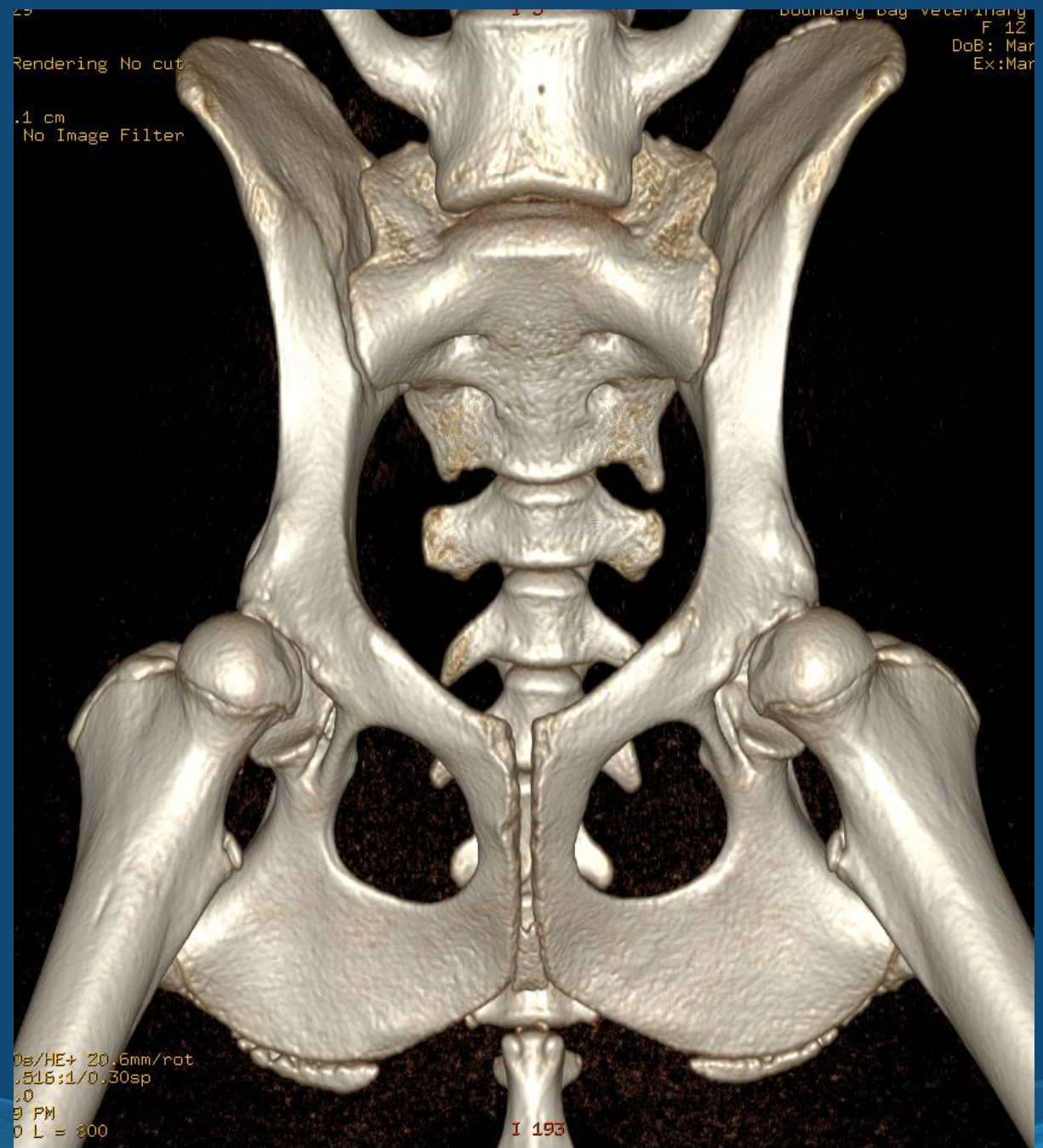
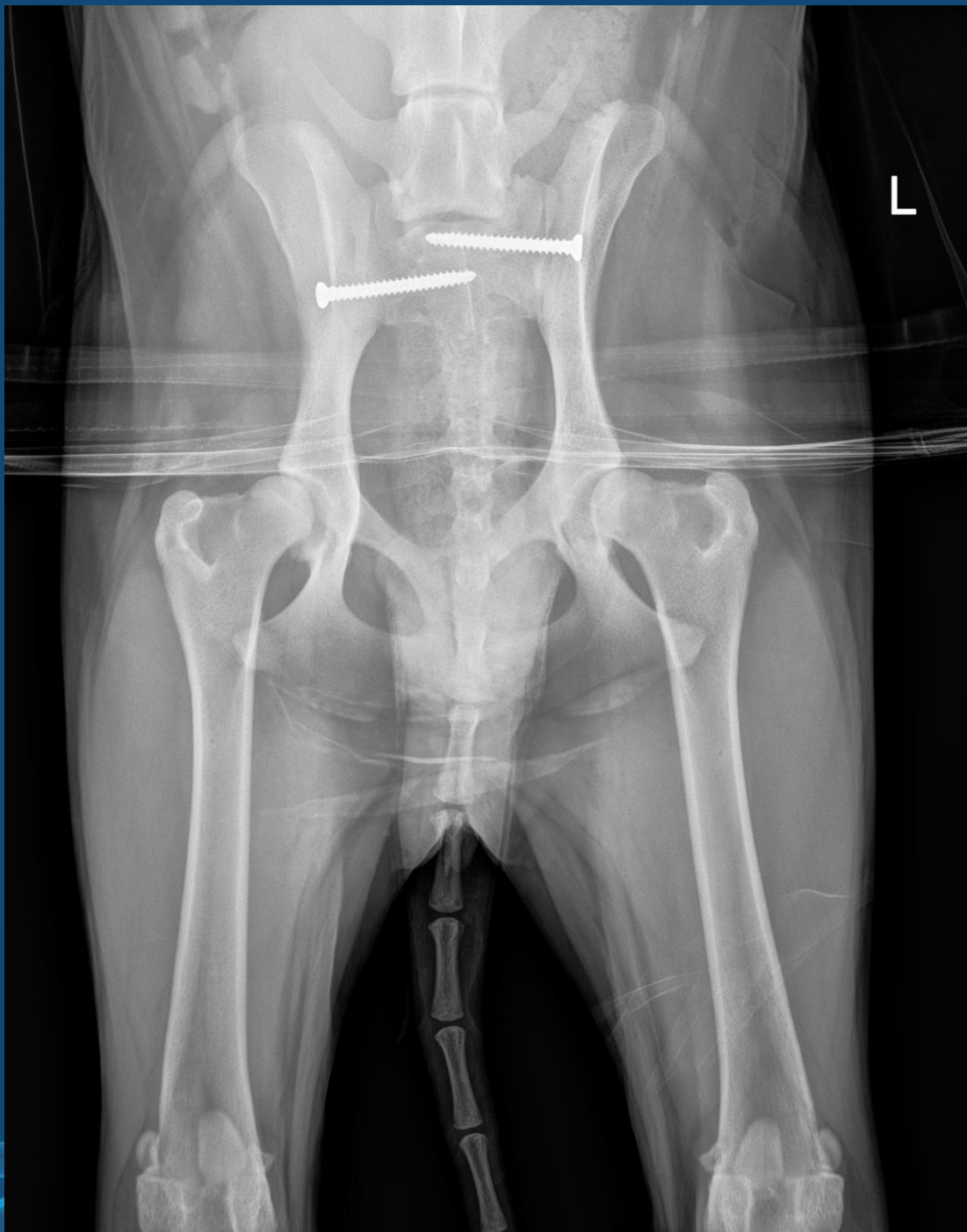
Hip Dysplasia

- **Diagnostics:**
 - VD pelvis radiograph
 - OFA vs PennHip
 - Pelvic CT scan



Hip Dysplasia





Hip Dysplasia

- **Treatment Options:**
 - Conservative Management
 - Juvenile Pubic Symphysiodesis (12-20 wks)
 - Triple or Double Pelvic Osteotomy (<12-14 months)
 - Total Hip Replacement
 - Femoral Head/Neck Osteotomy



Iliopsoas Strain

- **Common history:**
 - Primary: Acute onset of lameness, often after high-intensity activity
 - Secondary: Concurrent cause of pelvic limb lameness
 - May improve somewhat with rest, often minimal response to NSAIDs
- **Exam findings:**
 - Pain on direct palpation of iliopsoas tendon insertion on lesser trochanter or muscle mid-body
 - Pain on hip extension with concurrent internal rotation
 - Decreased hip excursion during gait
 - Mild external rotation of pelvic limb during stance phase
 - Concurrent source of pelvic limb lameness

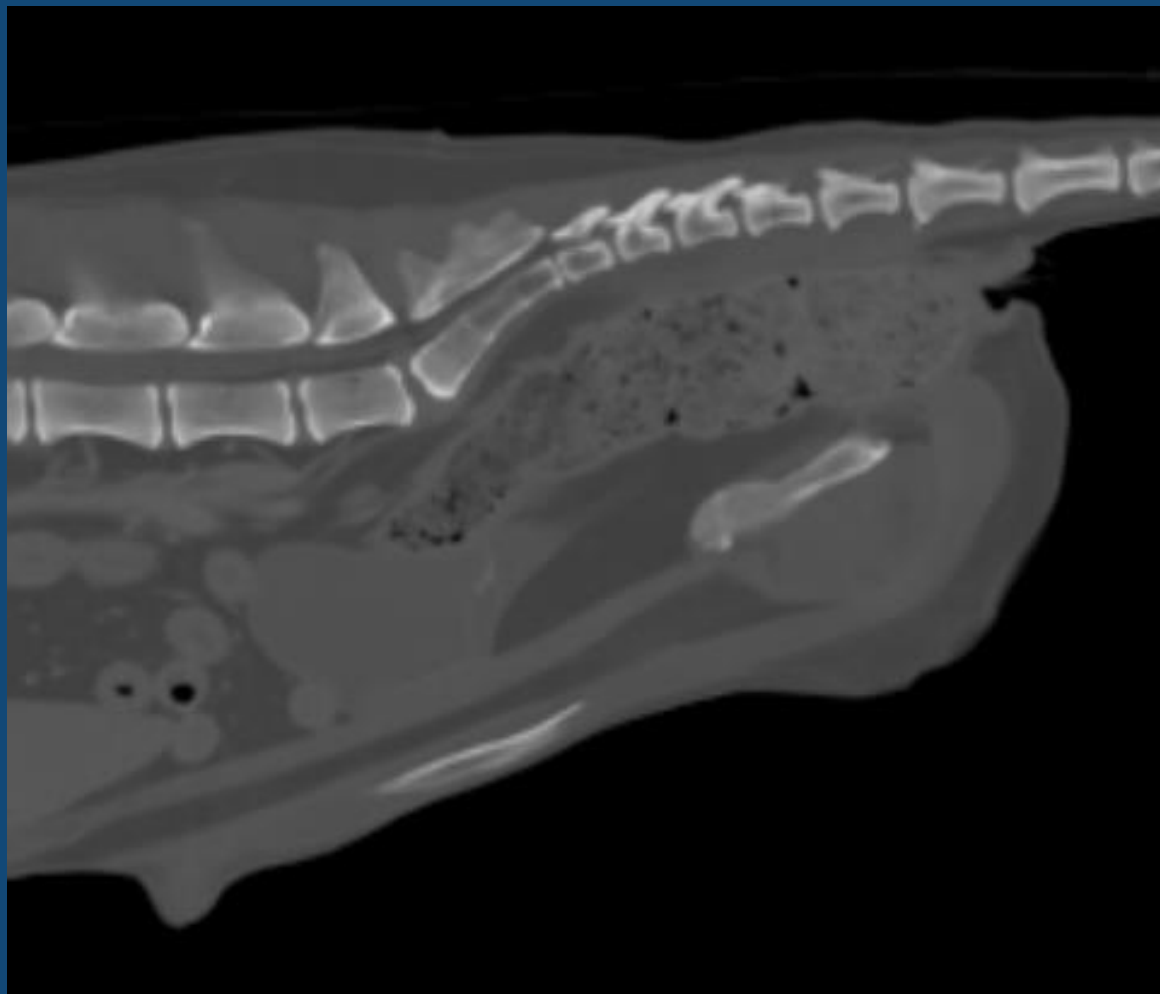


Iliopsoas Strain

- **Diagnostics:**
 - Ultrasound
 - MRI
- **Treatment Options:**
 - Treat primary source of lameness if present
 - Conservative management
 - Orthobiologics?
 - Tenectomy

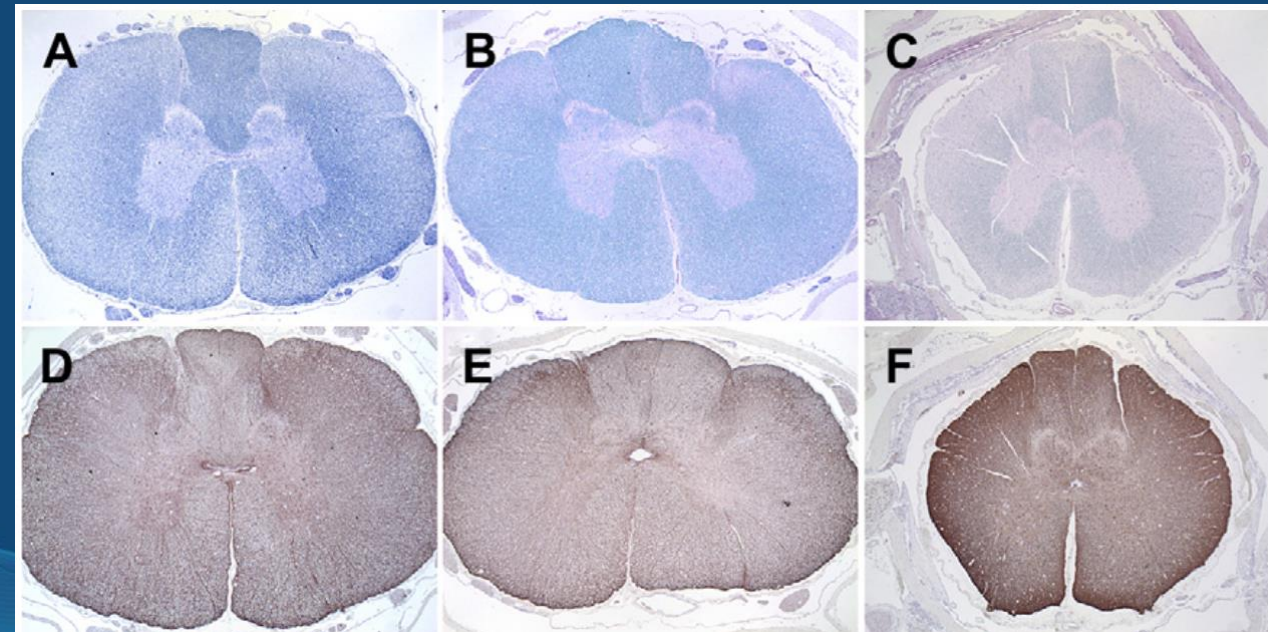






Degenerative Myelopathy

- Multisystem central & peripheral axonopathy
 - Degeneration of the axons of neurons in the spinal cord, then nerves
- Superoxide dismutase 1 (SOD-1) protein mutation
- Middle-older age of onset of neurologic signs
 - Typically >8 years
- Breed predilections:
 - German Shepherd
 - Boxer
 - Pembroke Welsh Corgi
 - Chesapeake Bay Retriever
 - Rhodesian Ridgeback
 - *(but can affect many breeds)*



Degenerative Myelopathy

- **Common history:**

- Scuffing / dragging of toes in pelvic limbs – progressively worse over several months
- Slow / insidious onset, progressive paraparesis & ataxia
- Can't jump like they used to
- No evident pain

- **Exam findings:**

- Variable severity paraparesis & ataxia
 - Starts as UMN paraparesis & GP ataxia (T3-L3 myelopathy)
 - Later stages: LMN paraparesis (L4-Cd myelopathy) → flaccid paraplegia to tetraplegia
- Often asymmetry of signs
- +/- hyporeflexia of pelvic limbs
- Loss of appendicular muscle mass (disuse + denervation atrophy)
- Lack of spinal pain



Degenerative Myelopathy

- **Diagnostics:**

- *Diagnosis of exclusion*
- SOD-1 genetic test
 - Homozygous mutation = “**at risk**”
 - Heterozygous = DM carrier; unlikely to develop clinical disease
 - Homozygous normal = unlikely to develop DM
- MRI
- CSF analysis

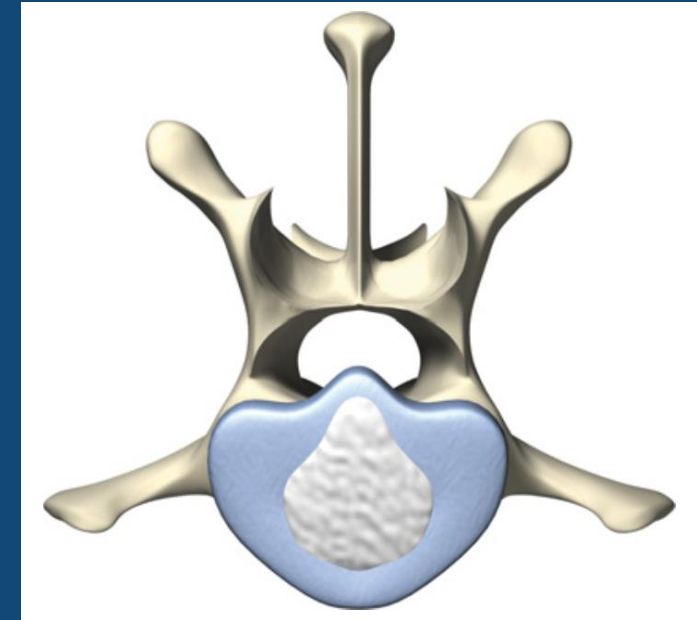
- **Treatment options:**

- *No definitive therapies*
- Physiotherapy



Intervertebral disc protrusion

- Age-related degeneration of the intervertebral disc – increased collagenization of the nucleus pulposus, weakening of the annulus fibrosus
- Weakening & micro-tears of the annulus fibrosus allow for focal bulging of the annulus & nucleus into the vertebral canal
 - Hansen type II
- More commonly occurs in non-chondrodystrophic breeds
- Typically >7 years old



Intervertebral disc protrusion

- **Common history:**
 - Typically older age of onset
 - Slow onset, progressive paraparesis (or tetraparesis) & ataxia; sometimes acute-on-chronic scenario
 - +/- evident pain
- **Exam findings:**
 - Varying degrees of paraparesis (tetraparesis) & GP ataxia, to paraplegia (tetraplegia)
 - Proprioceptive deficits
 - +/- Spinal reflex deficits
 - +/- Spinal pain



Intervertebral disc protrusion

- **Diagnostics**

- Spinal radiographs?
- MRI
 - Or CT/myelogram

- **Treatment options**

- Decompressive surgery
 - Hemilaminectomy
 - Mini-hemilaminectomy + corpectomy
 - Ventral slot
- Medical management – anti-inflammatory, analgesics
 - CRATE REST
 - 23 hours/day, short leashed walks for urination/defecation



10 yo M German Shepherd

- **Diagnostics**

- Radiographs (stifles, pelvis/hips)

- **Treatment**

- +/- Left TPLO
 - +/- THR vs. FHO



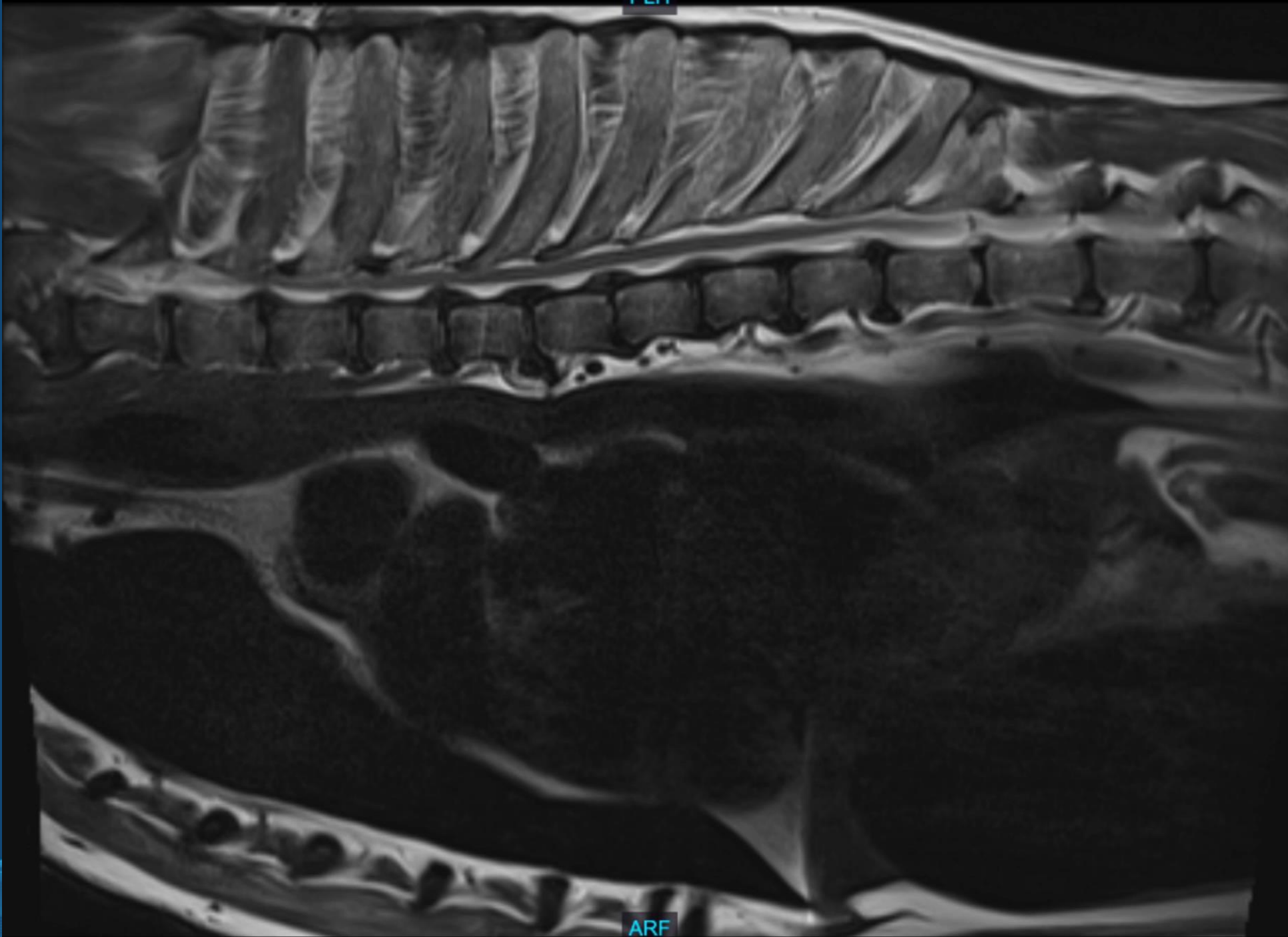
10 yo M German Shepherd

- **Diagnostics**

- Spinal radiographs (cervical, thoracolumbar)
- Cervical + thoracolumbar spine MRI

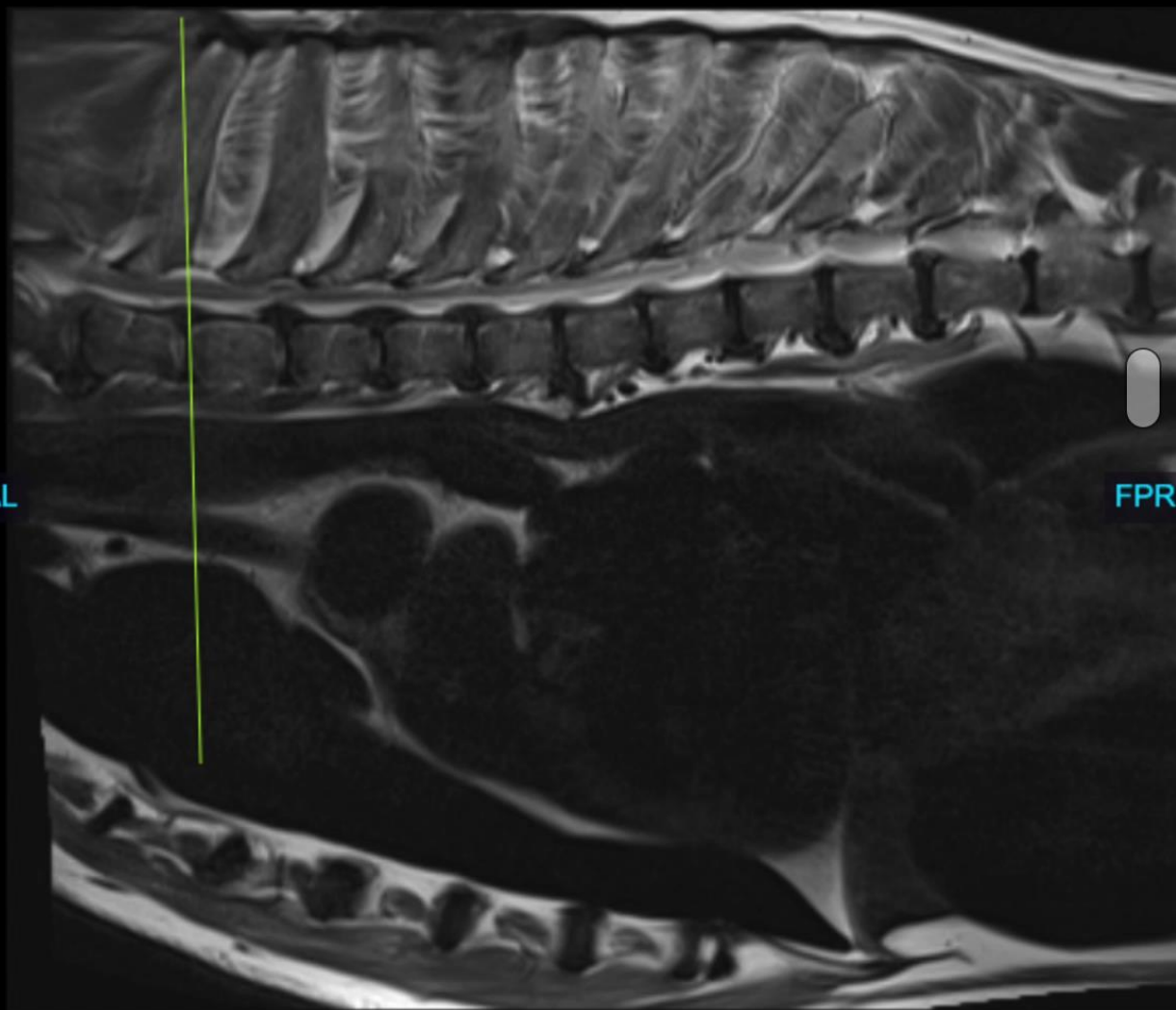


PLH



ARF





10 yo M German Shepherd

- **Diagnostics**

- Spinal radiographs (cervical, thoracolumbar)
- Cervical + thoracolumbar spine MRI

- **Treatment**

- Surgery – decompressive hemilaminectomy
- Medical management – anti-inflammatory prednisone, analgesics





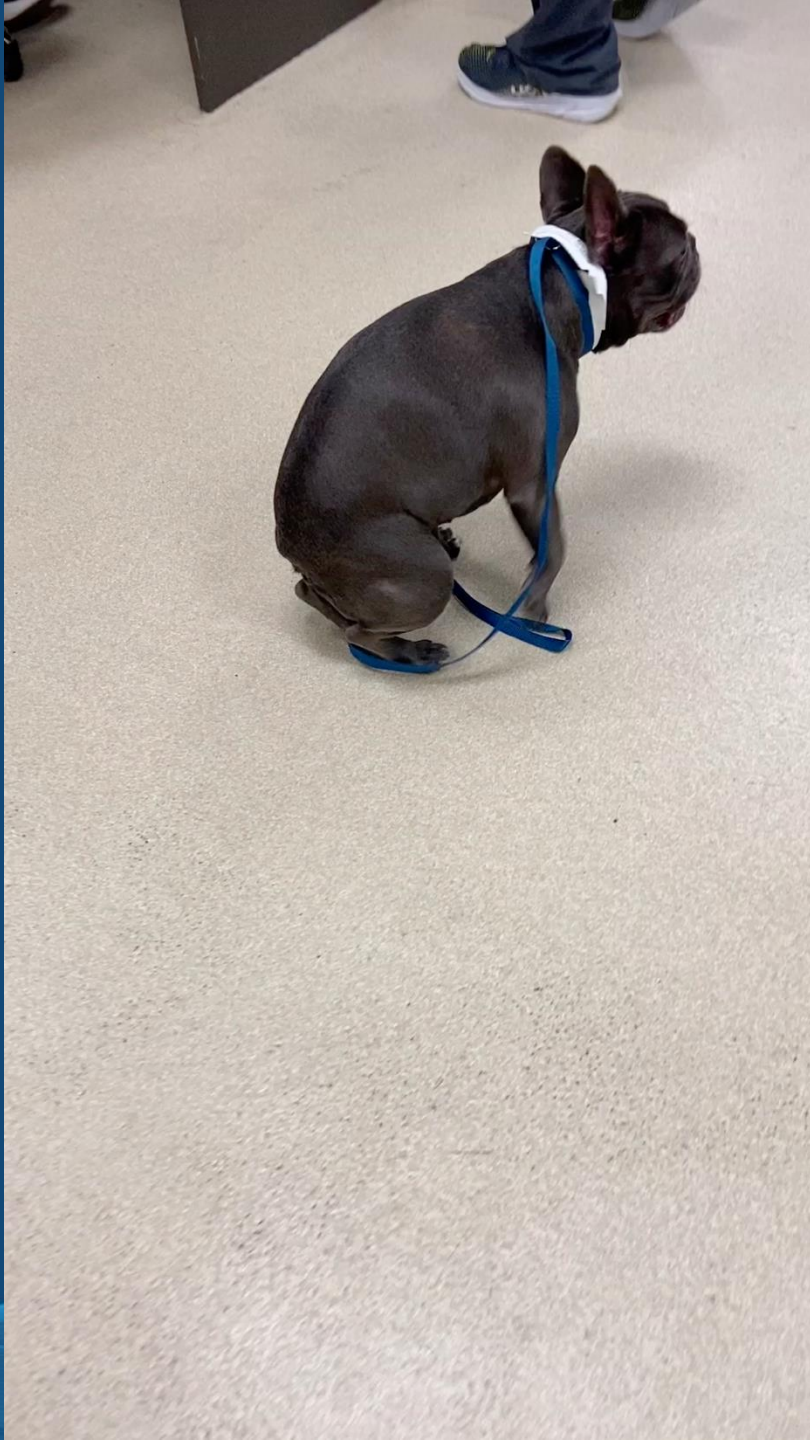
Case 6

Case Studies

4 yo FS French Bulldog

- **History:** acutely weak in hind limbs, cannot stand
 - Started showing signs of discomfort 2 days ago – more sedentary at home, reluctant to go for walks. Did not want to eat her dinner last night
 - This morning became suddenly unable to walk or stand; has been crouched in hind end





4 yo FS French Bulldog

■ Ortho Exam Findings:

- Gait: Hunched stance in pelvic limbs, incomplete hip/stifle extension
- Thoracic limbs: No joint pain, effusion, instability, or altered range of motion identified in any joint; long bones palpate normally
- Pelvic limbs: No stifle effusion or instability, comfortable on full ROM; no patellar luxation elicited bilaterally; hip, tarsus, digits, and long bones palpate normally; no overt iliopsoas pain on direct palpation



4 yo FS French Bulldog

- **Neuro Exam findings:**

- Mentation: Bright, alert, responsive
- Gait/posture: borderline ambulatory with apparent LMN weakness (vs. orthopedic weakness) in both pelvic limbs; has good motor function in both pelvic limbs but is unable to extend stifles. Has a crouched posture at all times in the pelvic limbs
- Cranial nerves: normal
- Postural reactions: absent paw placement & delayed hopping in both pelvic limbs
- Segmental reflexes/muscle tone: absent patellar x 2, apparently normal withdrawal x 4 (difficult to assess due to tucked posture of pelvic limbs), normal CT reflex, normal perineal reflex
- Spinal hyperesthesia: moderate pain on palpation in mid-lumbar region



4 yo FS French Bulldog

- What kind of weakness? Neurologic or orthopedic?

NEUROLOGIC

- Neurolocalization: L4-S3 myelopathy
 - vs. less likely partial manifestation of diffuse neuromuscular disease (due to presence of back pain)

Less likely to be bilateral orthopedic in a Frenchie with back pain...

- Bilateral hindlimb lameness (patellas, stifles)



4 yo FS French Bulldog

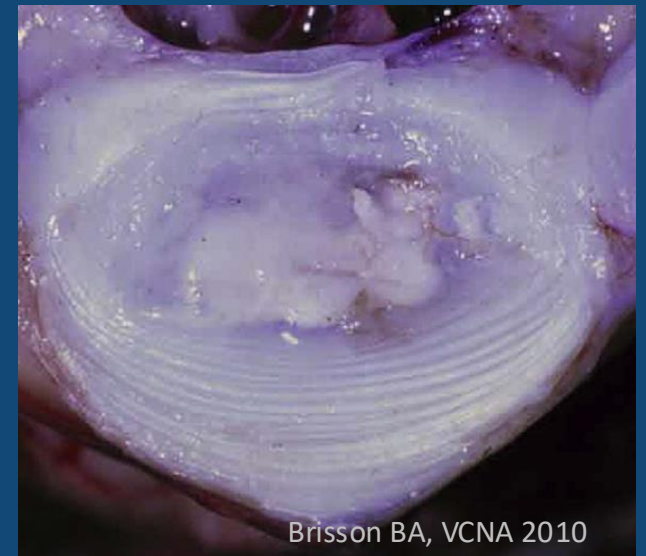
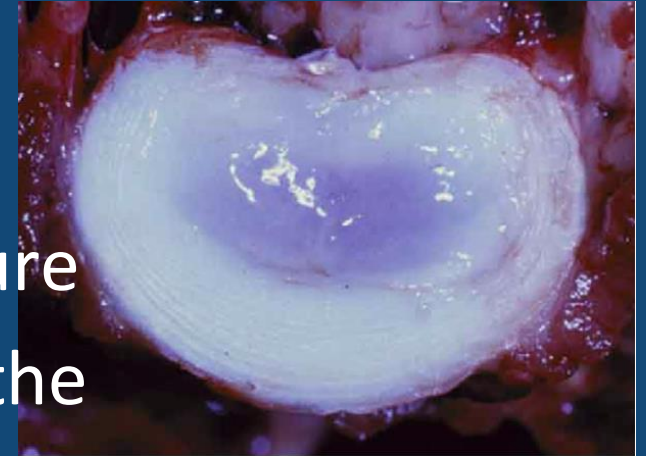
- Differentials?

- Intervertebral disc extrusion
- Intervertebral disc extrusion
- Intervertebral disc extrusion
- Meningomyelitis
- Neoplasia
- Consider the following with this gait abnormality if no evidence of back pain:
 - Myasthenia gravis
 - Bilateral cranial cruciate ligament disease
 - Bilateral high-grade medial patellar luxations



Intervertebral disc extrusion

- Degenerative changes to the intervertebral disc (chondroid metaplasia) → loss of hydroelastic properties, decreased ability to withstand pressure
- Extrusion of nucleus pulposus material through the ruptured annulus fibrosus
 - Hansen type I



Intervertebral disc extrusion

- **Common history:**

- Acutely having difficulty walking, or completely unable to walk
- +/- preceding signs of discomfort of variable duration
- May have jumped off a couch or bed, or suffered a different forceful impact to the spine
- May exhibit signs of pain only
 - Restlessness, pacing, freezing and not wanting to move, unable to sit/lay down, kyphotic posture, reluctance to bend down to food bowl, inappetence, withdrawn behaviors



Intervertebral disc extrusion

- **Exam findings:**
 - Varying degrees of paraparesis (or tetraparesis) & GP ataxia, to paraplegia (tetraplegia)
 - Sometimes ambulatory with no overt paraparesis or ataxia – may be painful only
 - Proprioceptive deficits
 - +/- Spinal reflex deficits
 - +/- diminished to absent nociception
 - Often focal spinal pain
 - Sometimes no overt focal pain



Intervertebral disc extrusion

- **Diagnostics**

- Spinal radiographs?
- MRI
 - Or CT vs. CT/myelogram

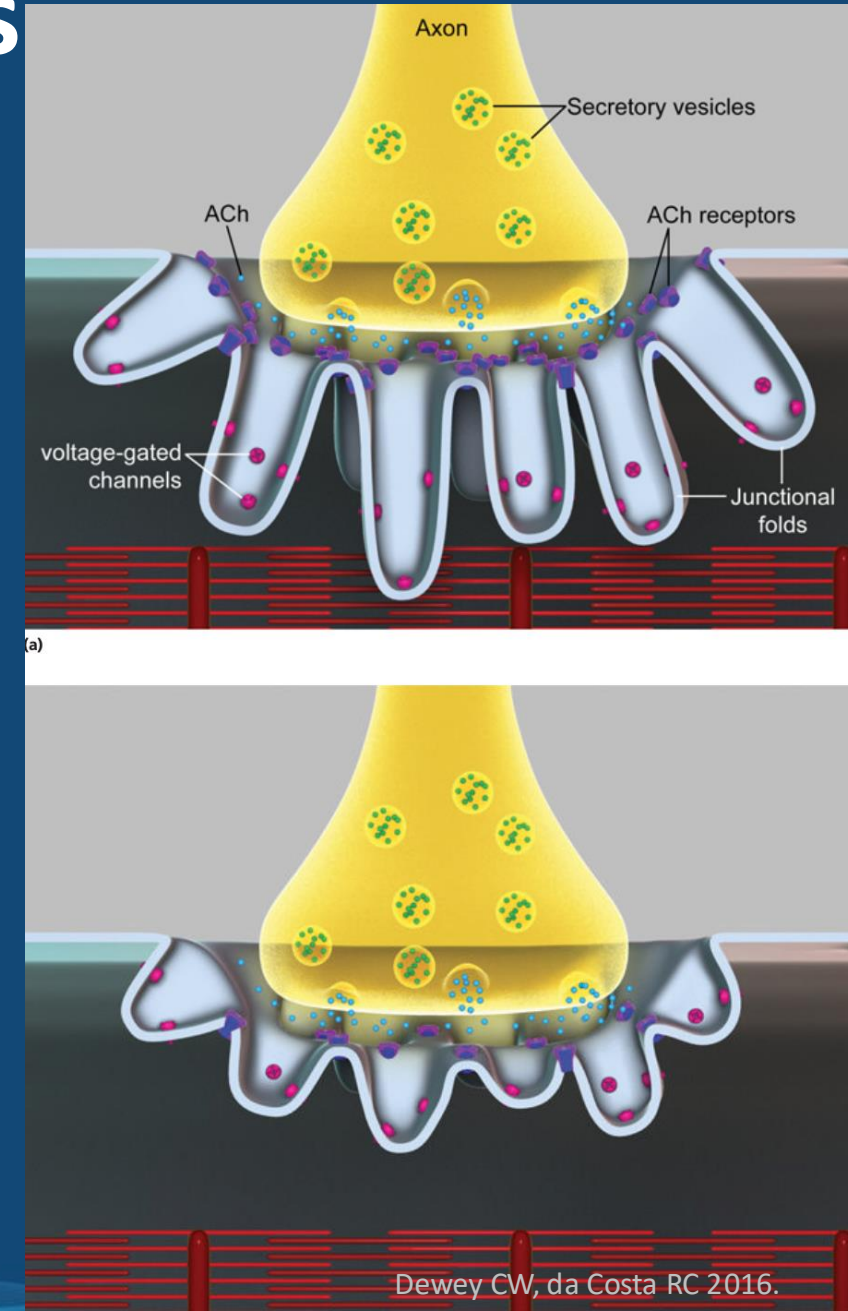
- **Treatment options**

- Decompressive surgery
 - Hemilaminectomy
 - Mini-hemilaminectomy
 - Ventral slot
 - Dorsal laminectomy
- Medical management – anti-inflammatory, analgesics
 - CRATE REST
 - 23 hours/day, short leashed walks for urination/defecation



Myasthenia gravis

- Acquired form – immune-mediated disease
 - Auto-antibodies against nicotinic acetylcholine (ACh) receptors on skeletal muscle membrane
- Decreased availability of ACh-receptors at the neuromuscular junction → decreased neuromuscular transmission
- Bi-modal age of onset
 - Dogs: <4 years, > 9 years
 - Cats: 2-3 years, 9-10 years



Myasthenia gravis

- **Common history:**

- Exercise-induced episodic fatigue
 - Short-strided gait progressing to crouched posture, possibly collapse
 - Often affects pelvic limbs first, then thoracic limbs
- +/- Hypersalivation, regurgitation, dysphagia, dysphonia

- **Exam findings:**

- Often normal if in a rested state
- Fatigable palpebral reflex
- After exercise: episodic LMN quality paresis, often of all limbs







Myasthenia gravis

- **Diagnostics:**
 - CBC/chemistry/UA
 - Thyroid panel
 - Baseline cortisol
 - Thoracic radiographs
 - Abdominal imaging
 - **Acetylcholine-receptor antibody titer (ACh-R Ab titer)**
 - Electrodiagnostics (repetitive nerve stimulation, single-fiber electromyography)



Myasthenia gravis

- **Treatment options:**
 - Anti-cholinesterase drugs
 - Make more ACh available at the NMJ for binding to the ACh-R that are available
 - Pyridostigmine bromide PO
 - Neostigmine IV
 - +/- Immunosuppressive therapy
 - Supportive care
 - Elevated feedings
 - Esophageal prokinetic medications, proton pump inhibitors
 - Monitoring for aspiration pneumonia



Patellar Luxation

■ Common history:

- Gait abnormality generally non-progressive but present from young age
- No history of trauma
- No significant improvement with rest/NSAIDs

■ Exam findings:

- Skipping gait when walking/trotting to consistent bowlegged gait
- Inducible patellar instability
- Minimal to mild stifle effusion
- +/- Cranial cruciate ligament instability

GRADE I

Knee cap can be manipulated out of its groove, but returns to its normal position spontaneously

GRADE II

Knee cap rides out of its groove occasionally and can be replaced in the groove by manipulation

GRADE III

Knee cap rides out of its groove most of the time but can be replaced in the groove via manipulation

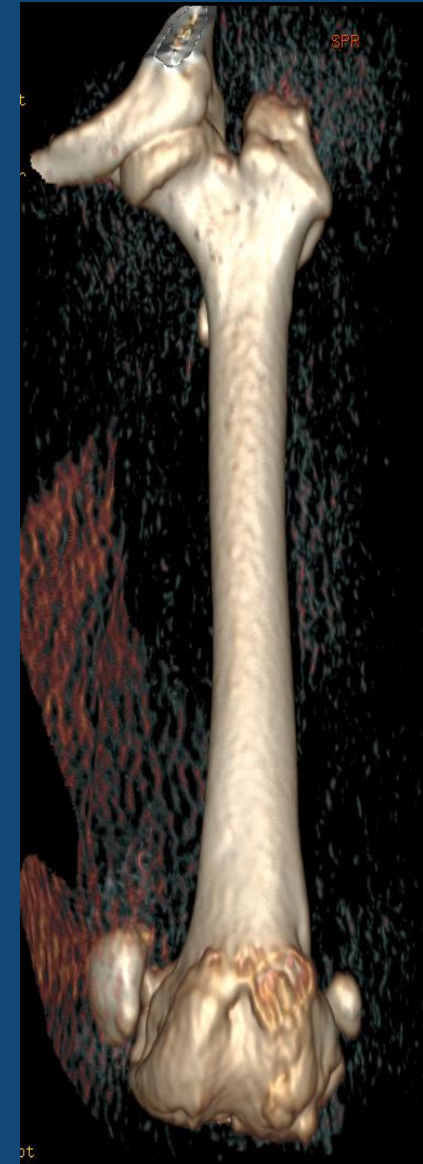
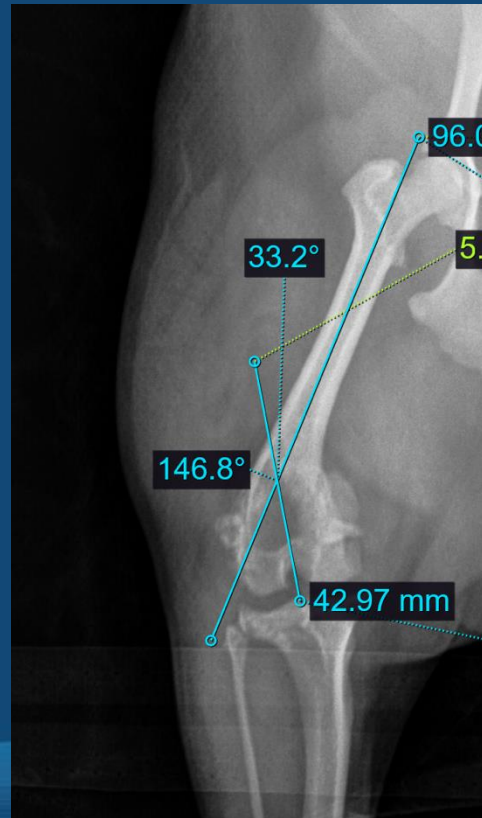
GRADE IV

Knee cap rides out of its groove all the time and cannot be replaced inside the groove



Patellar Luxation

- **Diagnostics:**
 - Orthogonal radiographs from pelvis to tarsus
 - CT scan



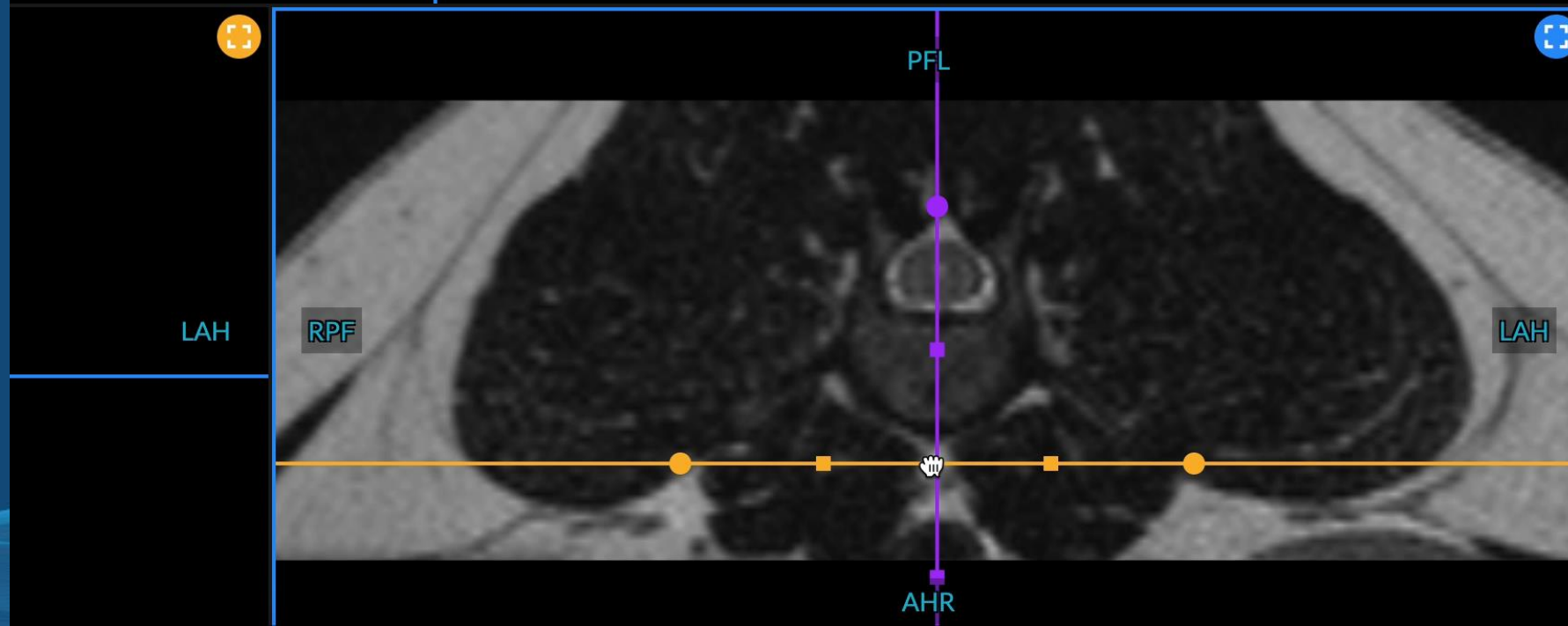
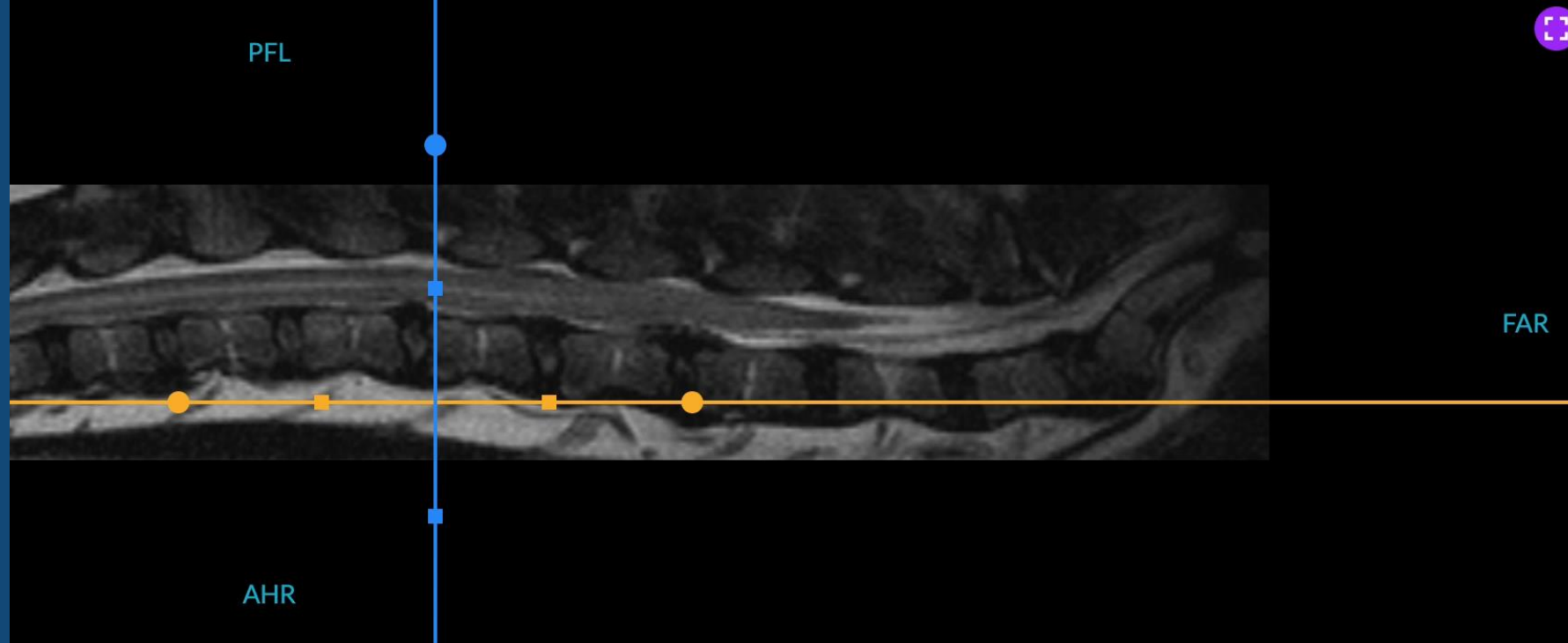
- Trochleoplasty
- Tibial tuberosity transposition
- Anti-rotational lateral fabellar suture
- Distal femoral osteotomy
- Soft tissue adjustments



4 yo FS French Bulldog

- **Diagnostics**
 - Spinal radiographs?
 - Thoracolumbar spine MRI





4 yo FS French Bulldog

- **Diagnostics**

- Spinal radiographs?
- Thoracolumbar spine MRI

- **Treatment**

- Surgery – decompressive hemilaminectomy
- Medical management – anti-inflammatory, analgesics
 - CRATE REST
 - 23 hours/day, short leashed walks for urination/defecation





Case 7

Case Studies

4 yo FS German Shepherd mix

- **History:** progressive weakness in all four limbs
 - 6 months prior, was noted to have elevated liver enzymes (ALT, ALP) on bloodwork. Recheck bloodwork this month showed progressively increased liver enzymes and CK





9/30/22 (Order Received)
9/30/22 1:56 AM (Last Updated)

3/29/22

TEST	RESULT	REFERENCE VALUE		
Glucose	81	63 - 114 mg/dL		74
IDEXX SDMA	^a 15	0 - 14 µg/dL	H	16
Creatinine	1.2	0.5 - 1.5 mg/dL		1.2
BUN	17	9 - 31 mg/dL		19
BUN: Creatinine Ratio	14.2			15.8
Phosphorus	4.6	2.5 - 6.1 mg/dL		4.3
Calcium	9.7	8.4 - 11.8 mg/dL		10.2
Sodium	151	142 - 152 mmol/L		149
Potassium	4.4	4.0 - 5.4 mmol/L		4.8
Na: K Ratio	34	28 - 37		31
Chloride	115	108 - 119 mmol/L		114
TCO2 (Bicarbonate)	22	13 - 27 mmol/L		24
Anion Gap	18	11 - 26 mmol/L		16
Total Protein	7.0	5.5 - 7.5 g/dL		6.7
Albumin	3.3	2.7 - 3.9 g/dL		3.2
Globulin	3.7	2.4 - 4.0 g/dL		3.5
Albumin: Globulin Ratio	0.9	0.7 - 1.5		0.9
ALT	540	18 - 121 U/L	H	401
AST	651	16 - 55 U/L	H	382
ALP	17	5 - 160 U/L		15
GGT	2	0 - 13 U/L		3
Bilirubin - Total	0.3	0.0 - 0.3 mg/dL		0.3
Bilirubin - Unconjugated	0.2	0.0 - 0.2 mg/dL		0.2
Bilirubin - Conjugated	0.1	0.0 - 0.1 mg/dL		0.1
Cholesterol	218	131 - 345 mg/dL		215
Amylase	1,046	337 - 1,469 U/L		770
Lipase	^b 74	0 - 250 U/L		53
Creatine Kinase	^c 8,515	10 - 200 U/L	H	4,931
Hemolysis Index	^d N			2+
Lipemia Index	^e N			1+



Chemistry



9/30/22 (Order Received)
9/30/22 1:56 AM (Last Updated)

3/29/22

TEST	RESULT	REFERENCE VALUE		
Glucose	81	63 - 114 mg/dL		74
IDEXX SDMA	^a 15	0 - 14 µg/dL	H	16
Creatinine	1.2	0.5 - 1.5 mg/dL		1.2
BUN	17	9 - 31 mg/dL		19
BUN: Creatinine Ratio	14.2			15.8
Phosphorus	4.6	2.5 - 6.1 mg/dL		4.3
Calcium	9.7	8.4 - 11.8 mg/dL		10.2
Sodium	151	142 - 152 mmol/L		149
Potassium	4.4	4.0 - 5.4 mmol/L		4.8
Na: K Ratio	34	28 - 37		31

ALT	540	18 - 121 U/L	H	401
AST	651	16 - 55 U/L	H	382
ALP	17	5 - 160 U/L		15
GGT	2	0 - 13 U/L		3
Bilirubin - Total	0.3	0.0 - 0.3 mg/dL		0.3
Bilirubin - Unconjugated	0.2	0.0 - 0.2 mg/dL		0.2
Bilirubin - Conjugated	0.1	0.0 - 0.1 mg/dL		0.1

Conjugated				
Cholesterol	218	131 - 345 mg/dL		215
Amylase	1,046	337 - 1,469 U/L		770

Creatine Kinase	^c 8,515	10 - 200 U/L	H	4,931
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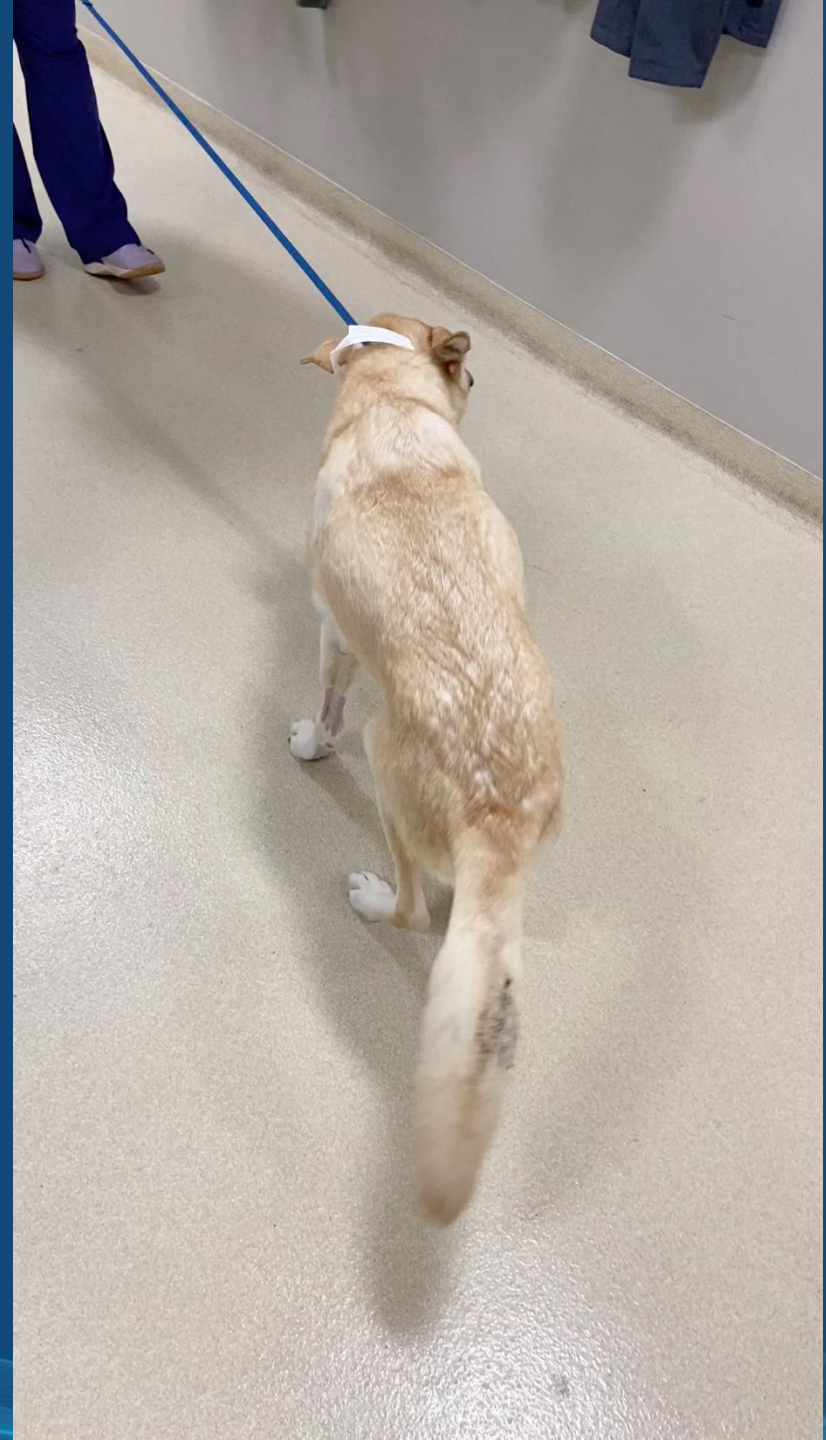
Hemolysis Index	^a N		2+
Lipemia Index	^e N		1+



4 yo FS German Shepherd mix

- **History:** progressive weakness in all four limbs
 - 6 months prior, was noted to have elevated liver enzymes (ALT, ALP) on bloodwork. Recheck bloodwork this month showed progressively increased liver enzymes and CK
 - Started on denamarin, prednisone (0.8 mg/kg/day), and amoxicillin due to suspicion of hepatopathy. Five days later, became weak on walks and progressed over a couple days to a non-ambulatory state, needing assistance for walks
 - Weight loss
- On presentation through Emergency service & during first 24 hours hospitalization, was febrile at 104.2°F (40.1°C)





4 yo FS German Shepherd mix

■ Ortho Exam Findings:

- Gait: Hunched stance in pelvic limbs, incomplete hip/stifle extension, significantly shortened swing phase bilaterally
- Thoracic limbs: No joint pain, effusion, instability, or altered range of motion identified in any joint; long bones palpate normally
- Pelvic limbs: No stifle effusion or instability, comfortable on full ROM; normal hip range of motion; no patellar luxation elicited bilaterally; tarsus, digits, and long bones palpate normally; no overt iliopsoas pain on direct palpation



4 yo FS German Shepherd mix

- **Neuro Exam findings:**
 - Mentation: Quiet, alert, responsive
 - Gait/posture: weakly ambulatory tetraparetic, short-strided gait x 4, crouched posture in pelvic limbs due to inability to fully extend stifles
 - Cranial nerves: normal
 - Postural reactions: normal paw placement & hopping in all four when weight is supported
 - Segmental reflexes/muscle tone: normal to slightly diminished muscle tone & mild muscle atrophy x 4, decreased patellar x 2, decreased withdrawal x 4
 - Spinal hyperesthesia: no spinal pain elicited; seems generally uncomfortable for handling



4 yo FS German Shepherd mix

- What kind of weakness? Neurologic or orthopedic?

EITHER IS POSSIBLE

NEUROLOGIC

- Neurolocalization: Diffuse neuromuscular (diffuse LMN)

MULTIFOCAL ORTHOPEDIC

- Lameness in all four limbs – hips, stifles, iliopsoas, elbows, shoulders



4 yo FS German Shepherd mix

■ Differentials?

MULTIFOCAL ORTHOPEDIC

- Immune-mediated polyarthropathy
- Bilateral hip luxation
- Bilateral cranial cruciate ligament disease
- Bilateral high-grade patellar luxation
- Bilateral hip dysplasia
- Bilateral iliopsoas strains
- Bilateral elbow dysplasia
- Bilateral biceps brachii tenosynovitis

paralysis”)

- Polyneuropathy
- Myasthenia gravis
- Myopathy
 - Infectious polymyositis
 - Immune-mediated polymyositis
 - Degenerative myopathy



Hip Luxation

- **Common history:**

- Acute onset of non-weightbearing lameness
- Often has trauma in history, can be minor if underlying severe hip dysplasia
- Does not improve with rest/NSAIDs
- May start toe-touching after several days/weeks

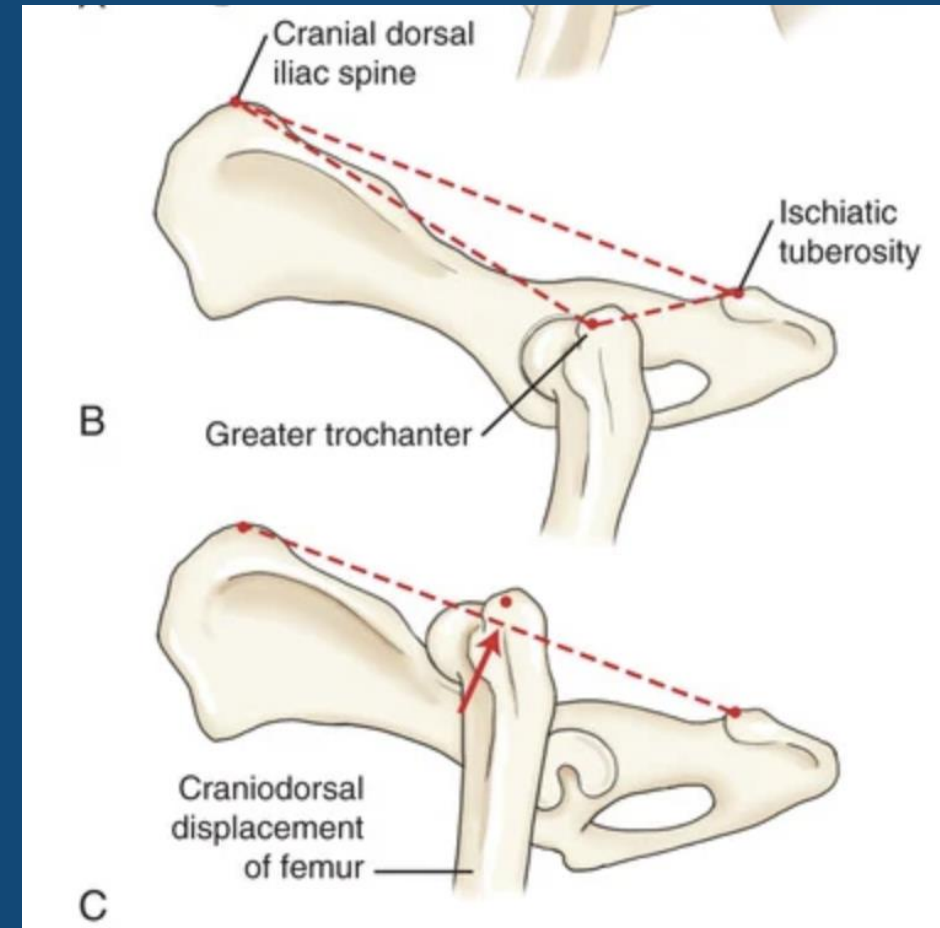
- **Exam findings:**

- Non-weightbearing to mild toe-touching lameness
- Pain +/- crepitus on ROM
- May have additional trauma



Hip Luxation

- **Exam Findings**
 - Craniodorsal luxation:
 - Limb shorter than contralateral
 - Dorsal displacement of greater trochanter
 - Caudoventral luxation:
 - Limb longer than contralateral
 - Limb often mildly abducted when standing



Hip Luxation

■ Diagnostics:

- Orthogonal pelvic radiographs
- Pelvic CT scan
- Coxofemoral ultrasound



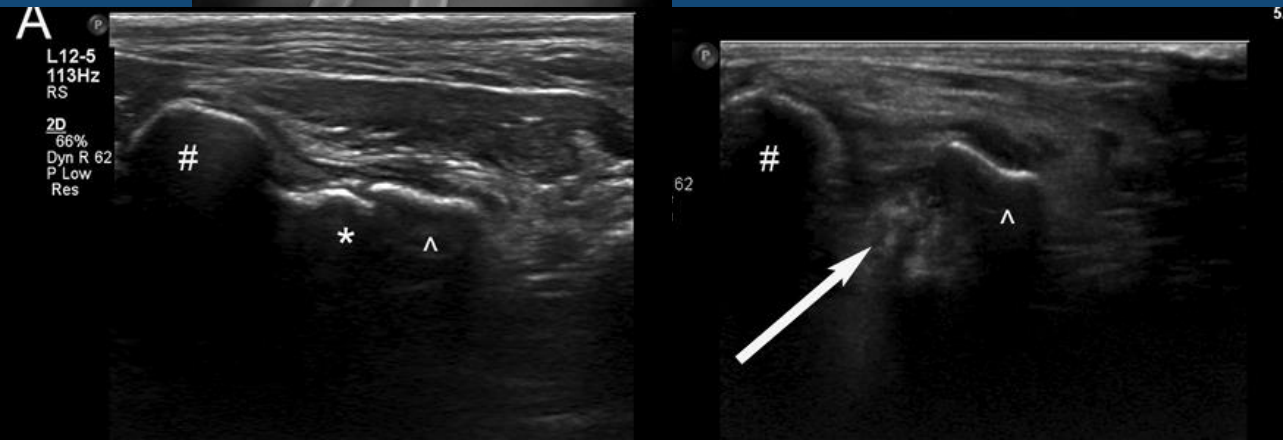
■ Treatment Options:

- Closed reduction
 - Ehmer sling
 - Hobbles
- Open reduction
 - Primary vs synthetic capsulorrhaphy
 - Iliofemoral suture
 - Deep gluteal tendon transposition

▪ Toggle-pin fixation

▪ Femoral head/neck ostectomy

▪ Total Hip Replacement



4 yo FS German Shepherd mix

- **Diagnostics**
 - CBC/chemistry/UA, CK, thyroid panel



Polymyositis

- Infectious
- Immune-mediated
 - Often idiopathic
 - Breed-associated forms – Newfoundlands, Boxers, Hungarian Vizsla
 - Paraneoplastic or pre-neoplastic syndrome
 - Lymphoma
 - Plasmacytoma
 - Middle-aged dogs – most common



4 yo FS German Shepherd mix

- **Diagnostics**

- CBC/chemistry/UA, CK, thyroid panel
- Thoracic / abdominal imaging (systemic screen)
- Infectious disease testing
 - Toxoplasma, neospora, 4DX
- Electrodiagnostics (electromyography, nerve conduction velocity, repetitive nerve stimulation)
- Muscle (+/- nerve) biopsies



Lab Findings

Bacteriology

Cryptococcus antigen LAT - 10/21/2022 11:26 AM

Specimen Cryptococcus antigen

Faye - Spayed - 5 Years

Serum - 1 Not detected

Parasitology

Neospora caninum antibody IFA - 10/27/2022 2:10 PM

Specimen Neospora caninum IgG

Faye - Spayed - 5 Years

Serum - 3 $\geq 1:800$

Neospora caninum
antibody IFA

Neospora caninum IFA: Sample screened at 1:50 which is the lowest detectable titer established by the test manufacturer; thus, titers $<1:50$ would be considered negative for IgG.

Specialized Infectious Disease

Toxoplasma gondii ELISA canine - 10/25/2022 2:06 PM

Specimen IgM IgG

Faye - Spayed - 5 Years

Serum - 2 Negative Negative

Toxoplasma gondii ELISA
canine

Detected: (Titer $\geq 1:64$): Antibodies against *Toxoplasma gondii* were detected at the reported titer and indicate previous or current infection with the agent. While IgG titers can be present chronically, IgM titers suggest recent infection. If clinical signs indicate possible *T. gondii* infection, treatment is indicated.

Not Detected: (Titer $< 1:64$): Antibodies against *T. gondii* were not detected in the serum sample provided which indicates lack of exposure or peracute infection.



UNIVERSITY of CALIFORNIA, SAN DIEGO
SCHOOL OF MEDICINE

Lab Director: G. Diane Shelton,
DVM, Ph.D.

Professor, Department of Pathology
musclelab@ucsd.edu

<http://vetneuromuscular.ucsd.edu>

BIOPSY REPORT

RE: Complete Muscle Profile (900)

STAINS EMPLOYED: H & E, modified trichrome, PAS, ATPases at pH 9.8 and 4.3, esterase, NADH-TR, acid Pase, alkaline Pase, oil red O, SPA-HRPO

Observation

Unfixed and fixed biopsies were submitted from the vastus lateralis muscle. The unfixed biopsy was evaluated in frozen sections and the fixed biopsy evaluated in paraffin. A moderate variability in myofiber size was present with scattered atrophic fibers having a round to anguloid shape and of both fiber types. Fiber type grouping was not observed. Intramuscular nerve branches were not present for evaluation. Scattered and multifocal areas of mixed mononuclear cell infiltrations were present with infiltrating cells composed of lymphocytes and acid phosphatase/esterase positive macrophages. Scattered peroxidase-reactive eosinophils were also present in the endomysium and perimysium. Numerous and scattered necrotic myofibers were undergoing phagocytosis. Myofiber loss and fibrosis were present in areas of marked inflammation. No organisms or other specific cytoarchitectural abnormalities were observed.

Conclusion

Regionally severe inflammatory (myositis) and necrotizing myopathy in the vastus lateralis muscle with patchy fiber loss and fibrosis. If an infectious cause is not identified (Toxoplasma, Neospora or tick-related diseases), an immune-mediated (polymyositis) or paraneoplastic syndrome would be likely.

G. Diane Shelton, D.V.M., Ph.D.
Diplomate, ACVIM (Internal Medicine)
Professor, Department of Pathology

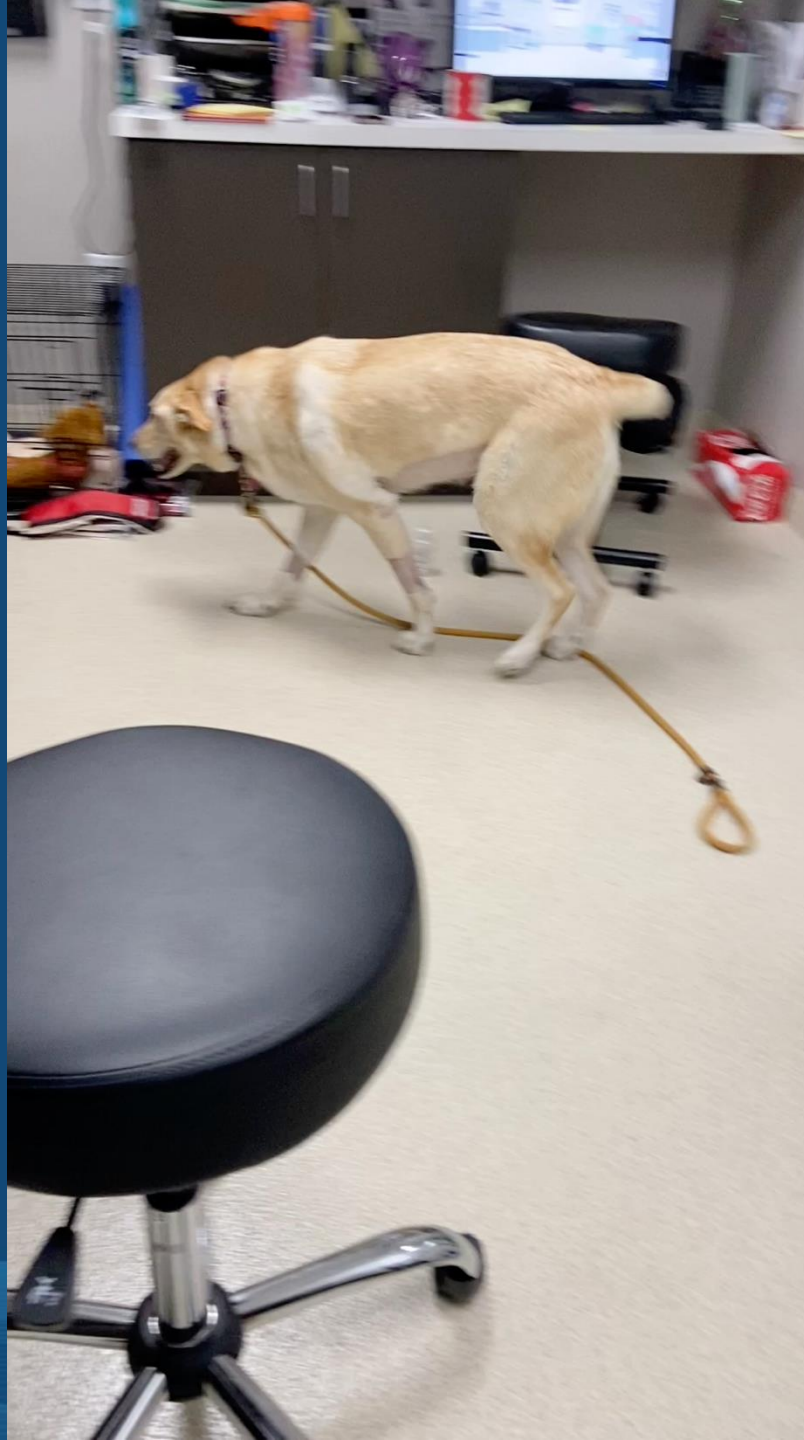


4 yo FS German Shepherd mix

- **Treatment**

- Clindamycin +/- trimethoprim/sulfamethoxazole
- +/- Pyrimethamine
- Anti-inflammatory steroid
- L-carnitine





Case 8

Case Studies

8 yo MN Labrador Retriever

- **History:** progressive left thoracic limb lameness and left Horner syndrome
 - Left eye started looking abnormal about 6 months ago
 - Lameness has been progressing over the past 2 months







8 yo MN Labrador Retriever

■ Ortho Exam Findings:

- Gait: Grade 2 left thoracic limb lameness
- Right thoracic limb: No joint pain, effusion, instability, or altered range of motion identified in any joint; long bones palpate normally
- Left thoracic limb: No elbow effusion or altered range of motion; no pain on biceps palpation; normal shoulder range of motion; carpus, digits, and long bones palpate normally
- Pelvic limbs: No stifle effusion or instability; normal hip range of motion; no patellar luxation elicited; tarsus, digits, and long bones palpate normally; no overt iliopsoas pain on direct palpation



8 yo MN Labrador Retriever

■ Neuro Exam findings:

- Mentation: bright, alert, responsive
- Gait/posture: ambulatory with left thoracic limb weight-bearing lameness, carpal hyperextension during weight-bearing phase of gait and concurrent ataxia of the left thoracic limb. The left pelvic limb also displays UMN/GP paresis/ataxia, not overtly apparent in right pelvic limb.
- Cranial nerves: ptosis / miosis / elevated nictitans OS, otherwise normal
- Postural reactions: slightly delayed hopping (and intermittently delayed paw placement) in left thoracic limb, otherwise normal
- Segmental reflexes/muscle tone: mild-moderate muscle atrophy of the left antebrachial muscles and only mild atrophy of the left shoulder muscles. Withdrawal reflex is normal in all limbs. Normal patellar reflex x 2. CT reflex is weak on left side when stimulated on both right & left, normal on right.
- Spinal hyperesthesia: No overt pain elicited on palpation of vertebral column. Seems consistently hyperesthetic and averse to handling of left thoracic limb



8 yo MN Labrador Retriever

- What kind of weakness? Neurologic or orthopedic?

NEUROLOGIC

- Neurolocalization: Left C6-T2 myelopathy + Horner syndrome

Less likely to be primary orthopedic with concurrent Horner syndrome...

- Left forelimb lameness: elbow, shoulder, foot



8 yo MN Labrador Retriever

■ Differentials?

ORTHOPEDIC

- Elbow dysplasia
- Biceps brachii tenosynovitis
- Foot/digit injury

NEUROLOGIC

- Neoplasia – peripheral nerve sheath tumor, lymphoma
- Lateralized intervertebral disc protrusion
- Meningomyelitis or brachial plexus neuritis



Elbow Dysplasia/Medial Coronoid Disease

- **Common history:**

- Progressive lameness, worse with activity or after rest
- Lameness often first noted after running/high intensity activity
- Improves with NSAIDs and rest
- May involve one or both forelimbs

- **Exam findings:**

- Elbow effusion
- Painful and/or decreased range of motion
- Pain on cubital test
- Often bilateral, with one limb affected more severely



Elbow Dysplasia/Medial Coronoid Disease

- **Diagnostics:**

- Orthogonal radiographs including hyperflexed lateral
- Forelimb CT scan
- Arthroscopic evaluation

- **Treatment Options:**

- Conservative management
- Arthroscopic debridement/fragment removal
- PAUL
- Canine Uni-compartmental Elbow Resurfacing (CUE)
- Total elbow replacement



Biceps Brachii Tenosynovitis

- **Common history:**
 - Chronic weightbearing lameness
 - Highly active dog
 - Generally no history of trauma
 - No improvement with NSAIDs
- **Exam findings:**
 - Pain on direct palpation of biceps tendon
 - Pain on shoulder flexion with concurrent elbow extension
 - Scapular muscle atrophy if chronic
 - Concurrent source of lameness may be present



Biceps Brachii Tenosynovitis

- **Diagnostics:**
 - Tendon/shoulder ultrasound
 - MRI
- **Treatment Options:**
 - Conservative management
 - Orthobiologics?
 - Biceps release +/- tenodesis
 - Treat underlying primary disease process, if present



Nerve sheath tumor

- **Common history:**
 - Progressive monoparesis, sometimes progressing to paraparesis or tetraparesis
 - *Trigeminal nerve – unilateral masticatory muscle atrophy*
 - May or may not exhibit evident pain



Nerve sheath tumor

- **Exam findings:**
 - Monoparesis if involving only the nerve/plexus
 - Paraparesis or tetraparesis if extending into the vertebral canal and causing spinal cord compression
 - Often GP ataxia & proprioceptive deficits
 - Diminished to absent spinal reflexes of the affected limb
 - Diminished to absent cutaneous trunci reflex (brachial plexus)
 - Horner syndrome (brachial plexus)
 - Hyperesthesia



Cutaneous trunci reflex pathway

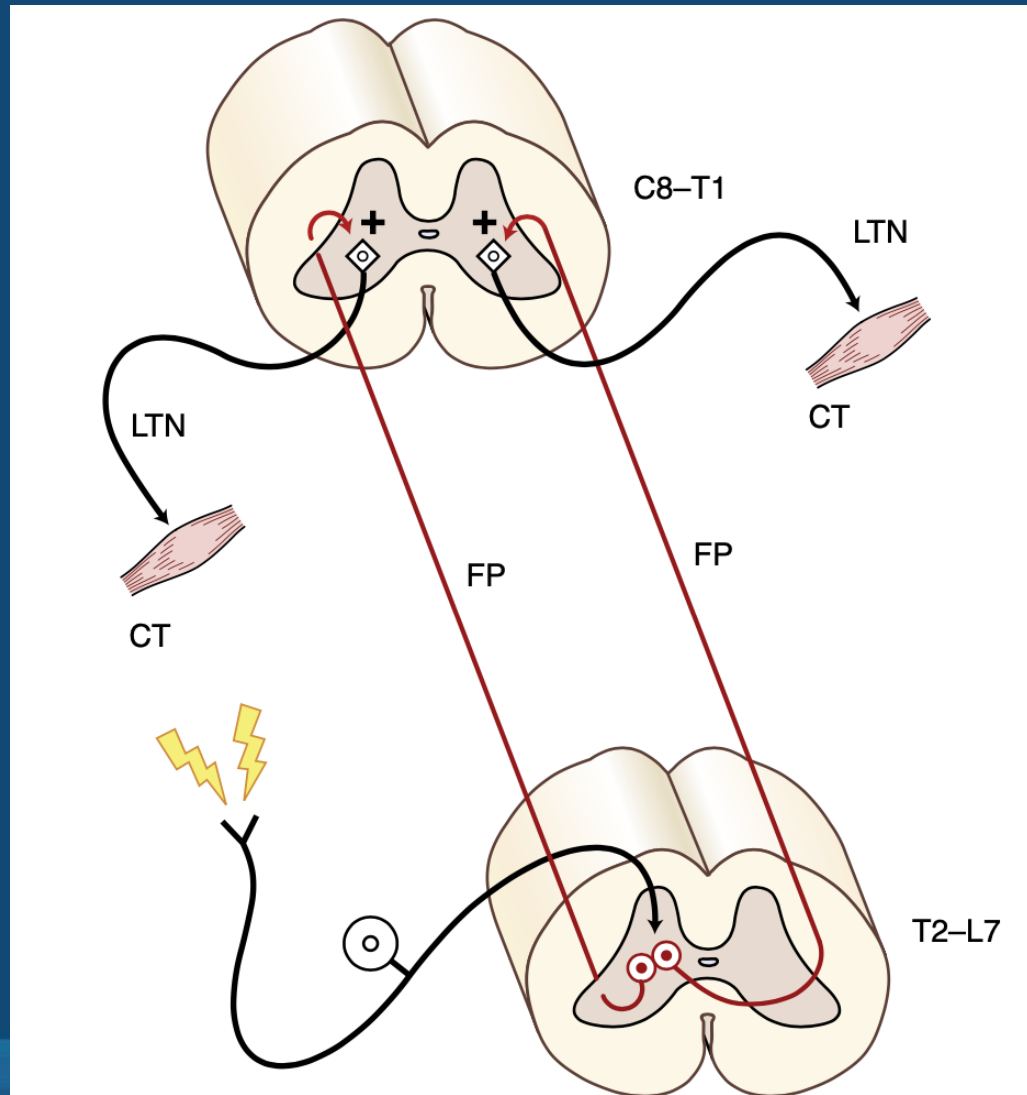
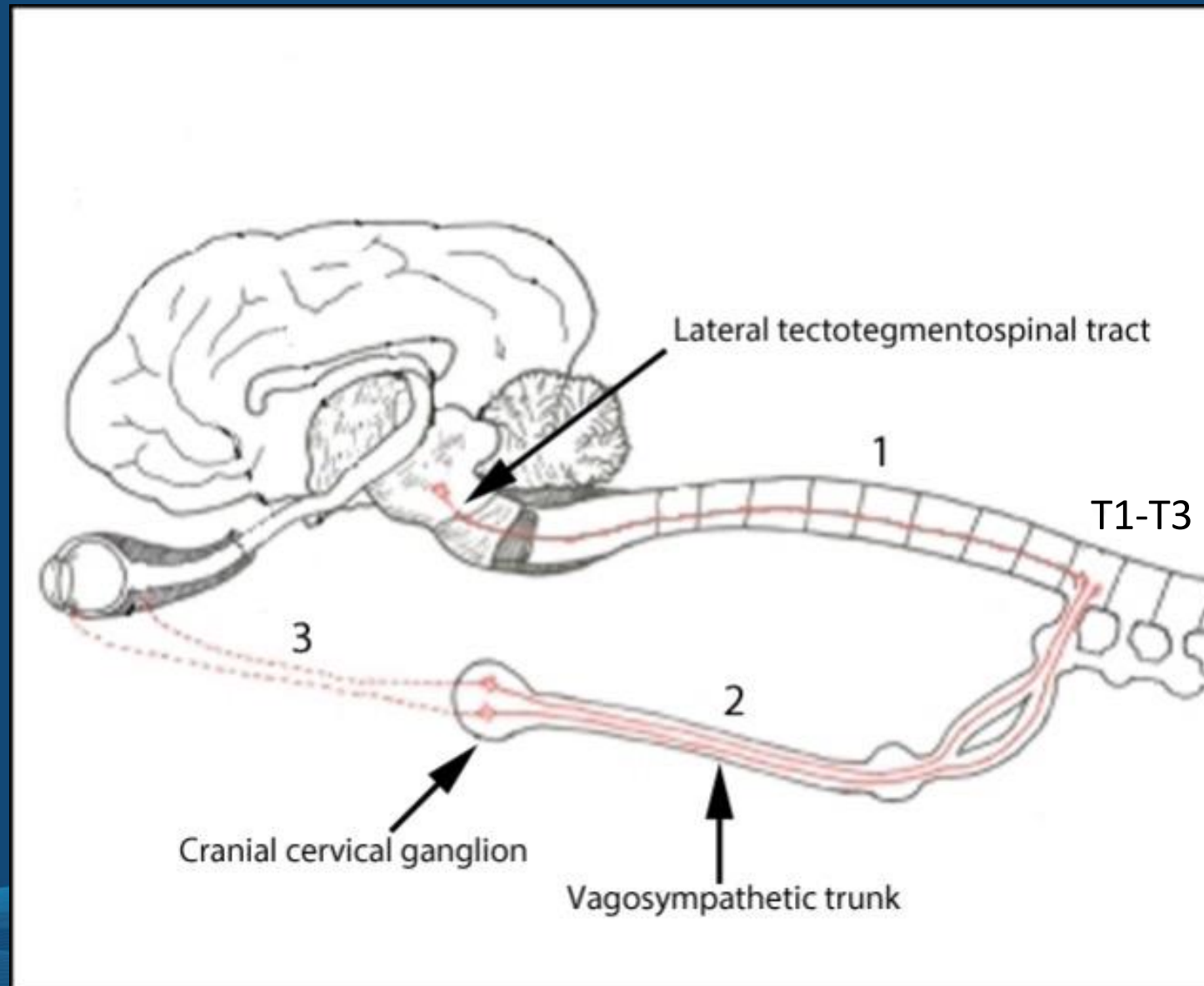


Fig. 5.9 Cutaneous trunci reflex. *CT*, Cutaneous trunci muscle; *FP*, fasciculus proprius; *LTN*, lateral thoracic nerve. Image: from de Lahunta's

Horner syndrome pathway



8 yo MN Labrador Retriever

- **Diagnostics**

- Orthogonal radiographs including hyperflexed lateral elbow view
- Cervical spine + brachial plexus MRI
- +/- CSF tap
- +/- Electrodiagnostics (electromyography, nerve conduction velocity)

- **Treatment (brachial plexus nerve sheath tumor)**

- Surgery – forelimb amputation +/- hemilaminectomy
- Adjunctive radiation therapy
- Medical management – anti-inflammatory steroid, analgesics



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