What is your diagnosis?

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HISTORY, SIGNALMENT AND EXAMINATION

A 5-year-old intact male Staffordshire bull terrier presented with a history of back pain. He had presented to the emergency service 10 days earlier for acute vomiting. The dog was painful on palpation of the midthoracic spine and abdomen at that time. The dog was treated overnight with intravenous fluid therapy and analgesics. Examination the following morning showed the dog had a deficit in conscious proprioception in the left hindleg and was mildly paretic in both hindlegs. He was discharged at that time.

At presentation to the specialty hospital, the dog was bright although appeared anxious. The owner reported no changes in the dog's mentation and no seizures to the owner's appreciation. Results of neurologic examination are below.[1]

Signalment: 5y/o MI Staffordshire Bull terrier

History & Physical exam:
2 w/k progressive history of spinal pain and left hind limb (LHL) ataxia

Mentation	BAR
Posture	normal
Gait/motor function	
mild ataxia to LHL, fully ambulatory	

CRANIAL NERVES

Left	Test (Innervation)	Right
	Menace/vision	
N	(II & VII)	N
M	Pupil size/symetry	M
	Small (S), Medium (M), Large (L)	
	Horner's Syndrome	
No	(Sympathetic trunk)	No
	Direct pupilliary light reflex	
N	(II & III)	N
	Indirect pupilliary light reflex	
N	(II & III)	N
	Strabismus	
No	(III, IV, & VI)	No
	Spontaneous nystagmus	
No	(III, IV, VI, & VIII)	No
	Positional nystagmus	
No	(III, IV, VI, & VIII)	No
	Palpebral	
N	(V & VII)	N
	Facial sensation (V):	
N	ophthalmic	N
N	maxillary	N
N	mandibular	N
	Facial symmetry/expression	
N	(VII)	N
	Temporal muscle mass	
N	(V)	N
	Jaw tone	
N	(V)	N
	Swallowing "gag reflex"	
N	(IX & X)	N
	Tongue	
N	(XII)	N
	Hearing	
N	(VIII)	N

BLADDER PALPATION/FUNCTION

Voluntary urination? Yes No (NE)
Bladder distension? Yes (No) NE
Incontinence? Yes (No) NE
Ease of manual expression?
Easy Hard (NE)

MUSCLE PALPATION

Left	Test	Right
Front N	Tone	N
Hind N		N
Front No	Atrophy	No
Hind No		NO

POSTURAL REACTIONS

Left	Test	Right
Front N	Consious proprioception	N
Hind 0	(paw position)	N
Front NE	Tactile placing	NE
Hind 0		N
Front NE	Wheelbarrow	NE
Hind NE	Dancing	NE
Front NE	Hemistanding/Hemihopping	NE
Hind NE		NE

SPINAL REFLEXES & DEEP PAIN PERCEPTION

	Left	Reflex (Innervation)	Right
Frontlimb		Biceps Brachi	
	N	(Musculocutaneous; C6-C8)	N
		Triceps	
	N	(Radial; C7-T1)	N
		Extensor Carpi Radialis	
	N	(Radial; C7-T1)	N
		Withdrawl	
	N	(C6-T2)	N
	YES	Deep Pain Perception	YES
	NO		NO
Hindlimb		Quadriceps (Patellar)	
	↑	(Femoral; L4-6)	N
	↑	Cranial tibial	N
		(Sciatic, peroneal branch; L6-L7)	
	↑	Gastrocnemius	N
		(Sciatic, tibial branch; L7-S1)	
		Direct sciatic	
	↑	(Sciatic; L6-S1)	N
		Withdrawl	
	↓	(Sciatic; L6-S1)	N
		Perineal	
	N	(Pudendal; S1-S2)	N
	(YES)	Deep pain perception	(YES)
	NO		NO

SPINAL HYPERESTHESIA YES (NO) NE
Location:

CUTANEOUS TRUNCI (Panniculus)(level of cut-off)
Left: present but weak caudal midlumbar
Right: N

LESION LOCALIZATION
Intracranial: Forebrain Brainstem Cerebellum
Vestibular (Peripheral / Central)
Spinal Cord
C1-C5 C6-T2 T3-L3 L4-S3
Grade: 1 2 3 4 5
Multifocal CNS
Peripheral Nerve
Local
General
Neuromuscular
Normal

Key: Abscent (0), Decreased (↓), Normal (N), Increased (↑), Clonus (↑↑), Not examined (NE)

Localise the lesion to the affected spinal cord segment. List your differential diagnoses. What diagnostics are indicated?

Findings on the neurologic examination localise the lesion to the third thoracic to third lumbar (T3-L3) spinal cord segment, more lateralized to the left. Differential diagnoses included Hansen type II intervertebral disc disease with lateralisation of compression, neoplasia (intramedullary, intradural, or extradural), discospondylitis, meningitis, or other compressive lesions such as an arachnoid cyst.

The initial diagnostic plan included a complete blood count, serum biochemistry analysis with electrolytes, and urinalysis. The complete blood count was unremarkable. Serum biochemistry revealed an elevated creatinine kinase (281 U/L; reference interval 47-228 U/L), mild elevation in urea (11.5 mmol/L; reference interval 3.6-10 mmol/L), mild hyperalbuminemia (40.4 g/L; reference interval 24.0-38.0 g/L), mild hypernatremia (159 mmol/L; reference interval 136-154 mmol/L), mild hyperchloremia (120 mmol/L; reference interval 100-117 mmol/L), and hypercholesterolemia (8.9 mmol/L; reference interval 3.3-6.9 mmol/L). The dog was assessed as slightly dehydrated although urine was not collected to confirm this.

Cerebral spinal fluid (CSF) as collected via a cerebellomedullary cisternal puncture. The CSF had a mildly elevated protein concentration (0.27 g/L; reference interval 0.10-0.25 g/L) and normal cell numbers with evidence of blood contamination. The mildly elevated protein concentration was likely due to blood contamination although neoplasia and intervertebral disc disease could not be ruled out. A cryptococcal serum antigen test was negative.

Radiographs of the cervical through lumbar spine were considered normal. A myelogram with subarachnoid injection of iohexol 300mg I/ml (Omnipaque, GE Healthcare Pty Limited Rydalmere, New South Wales) at 0.42 ml/kg followed by radiography and computed tomography (CT) was performed. On the radiographs, there was poor subarachnoid opacification and some epidural contrast present (Figure 1). Only the lateral view, centred over the T3-L3 is shown. The ventrodorsal projection does not add to the assessment. A transverse CT image is shown (Figure 2A), with a normal transverse image for comparison (Figures 2B) and a dorsoventral reconstruction (Figure 2C).

Identify any abnormal finding on the radiographic myelogram and CT myelogram. What would be indicated to further characterise any findings?

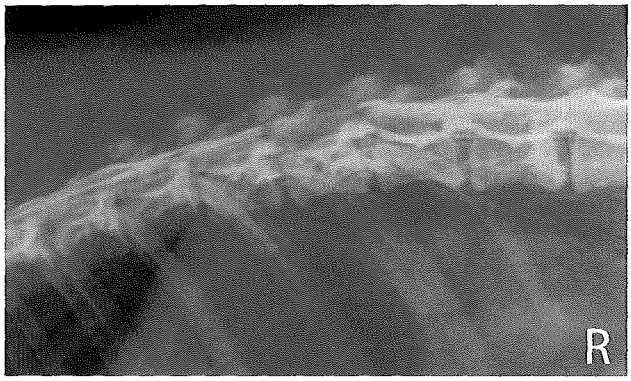

Figure 1. Computed tomography myelogram (kVp: 110, mA: 125, ms: 1500) of a 5-year-old intact male Staffordshire terrier with hindleg paresis. A) Transverse image at midbody of the 13th thoracic vertebrae (T13). B) Computed tomography at th e T12-T13 intervertebral disc space showing a normal spinal cord and myelogram for comparison. C) Dorsal reconstruction of the thoracolumbar region.

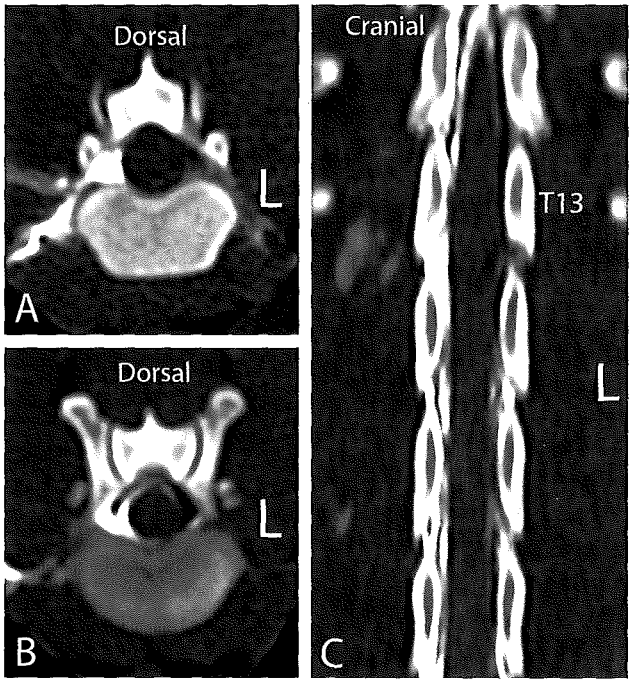

Figure2. Radiographic myelogram. Right lateral radiographic projection of the thoracolumbar vertebrae of a 5-year-old intact male Staffordshire terrier with hindleg paresis, taken after a lumbar-injection of iodinated contrast of iohexol (0.42 mL/kg). Note, there was poor subarachnoid opacification and some epidural contrast present.

There was a subjective increase in the volume of soft tissue within the neural canal and loss of epidural and subarachnoid contrast from the mid body of T13 to the mid body of L1 (Figure 3). This is especially obvious in the dorsal dye column, where there is thinning of the contrast column within T13 and complete filling craniad and caudad to this location. There was no evidence of bone lysis or proliferation in this area. A lesion within the spinal cord from mid T13-L1 was suspected but could not be fully characterized. The increase in soft tissue within the canal through this T13-L1 region most likely reflects an intramedullary lesion or an extradural lesion with an intramedullary component. An intradural extramedullar lesion was also a possibility. The lesion was identified was directly over a disc space therefore intervetebral disc disease could not be excluded but was considered less likely based on the signalment of the dog.

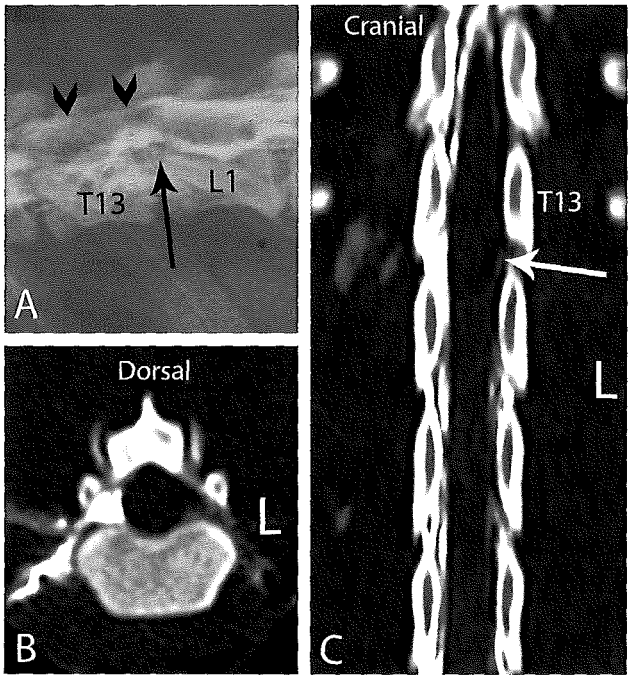

Figure 3. A) Radiographic myelogram. The radiographic image at the thoracolumbar region shows a loss of the ventral subarachnoid contrast column over the 13th thoracic (T13) and 1st lumbar (L1) intervertebral disc space (black arrow) with a thinning of the dorsal contrast column (arrow heads). B) Computed tomography myelogram (kVp: 110, mA: 125, ms: 1500). The transverse image at the midbody of T13 shows a subjective increase in the volume of soft tissue within the neural canal. C) Dorsal reconstruction of computed tomography images at the thoracolumbar region shows an increase in the volume of soft tissue within the neural canal and loss of epidural and subarachnoid contrast from the mid body of the T13 to the mid body of L1. The spinal cord appears enlarged on the left at the T13-L1 region (white arrow)

Further characterisation would require CT with intravenous contrast (iohexol 300 mg I/ml at 1.75 mL/kg IV). A uniformly enhancing lesion with a broad base over the left dorsolateal lamina was identified in the left dorsal spinal cord in the mid to caudal T13 region (Figure 4). The lesion measures 7.3 mm x 3.8 mm in the transverse plane and 8.9 mm in length. This is most consistent

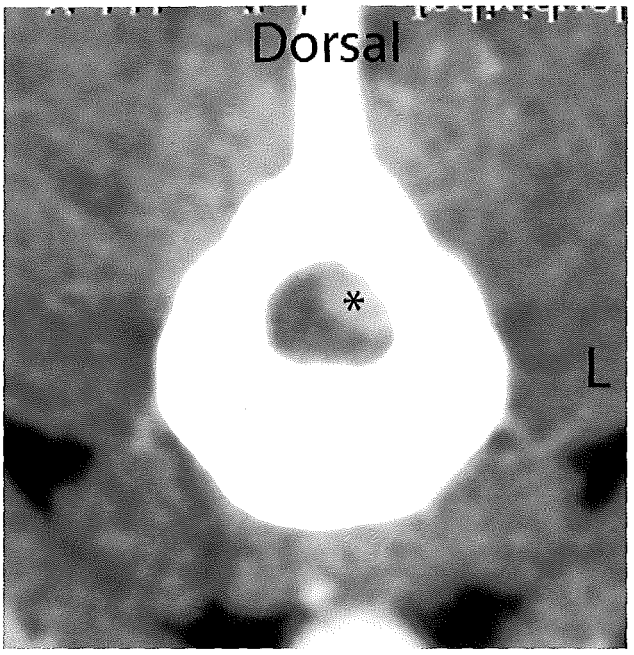

Figure 4. Transverse computed tomography image taken after intravenous contrast with iohexol (1.75 mL/kg IV) (kVp: 110, mA: 125, ms: 1500) of a 5-year-old intact male Staffordshire terrier with hindleg paresis. A uniformly enhancing broad-based mass over the left dorsolateral lamina was identified in the left dorsal spinal cord in the region of the mid to caudal 13th thoracic vertebrae (*).

with neoplasia such as meningioma or lymphoma although an inflammatory lesion or granuloma could not be excluded.

Surgical decompression with biopsy was recommended and performed the following week. A left sided hemilaminectomy from T12-L1 revealed a discoloured area of spinal cord at the dorsal aspect. A durotomy was performed which revealed a pale pink mass continuous with the spinal cord. The mass had a broad base with a 3 mm pedunculated region that extended caudally and was compressive to the underlying spinal cord (Figure 5). An incisional biopsy was performed of the mass. The hemilaminectomy was extended to fully decompress the affected region and the spinal cord was covered with an adipose graft from the subcutaneous tissue. The surgery site was closed and recovery from anaesthesia was uneventful.

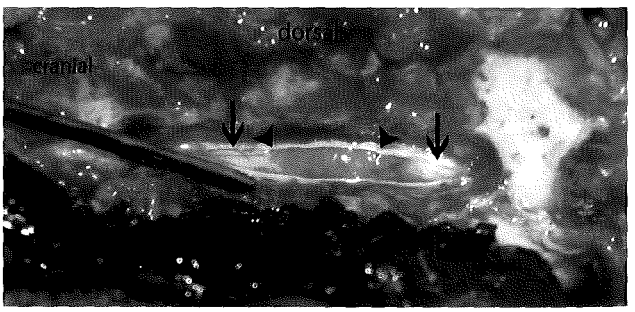

Figure 5. Intraoperative appearance after left hemilaminectomy at the 12th thoracic to 1st lumbar vertebrae of a 5-year-old intact male Staffordshire terrier with hindleg paresis. The dura has been opened. A pink fleshy mass with a broad base is seen (between arrow heads) which was confluent with the normal spinal cord (arrows).

The dog's neurologic examination was unchanged the next day with only a subtle subjective increase in weakness to the left hind limb. The dog was discharged to the owner two days after surgery with instructions for crate confinement. The dog was on carprofen and tramadol as previously prescribed.

Two weeks following surgery the dog remained ambulatory with a mild left sided paresis, unchanged from before surgery. Histopathology revealed a monomorphometric population of proliferative epithelial cells that are frequently forming tubular structures. One area of cells formed a small chamber with an invaginating growth resembling an embryonic glomerular tuft. Continuous with the tubule in many places, the neoplastic cells are arranged in solid sheets which contain scant cytoplasm and moderate to marked anisokayrosis, lacy chromatin, and occasional small nucleoli and frequent mitotic figures (Figure 6). Histopathology of the spinal cord lesion was consistent with a spinal cord nephroblastoma.

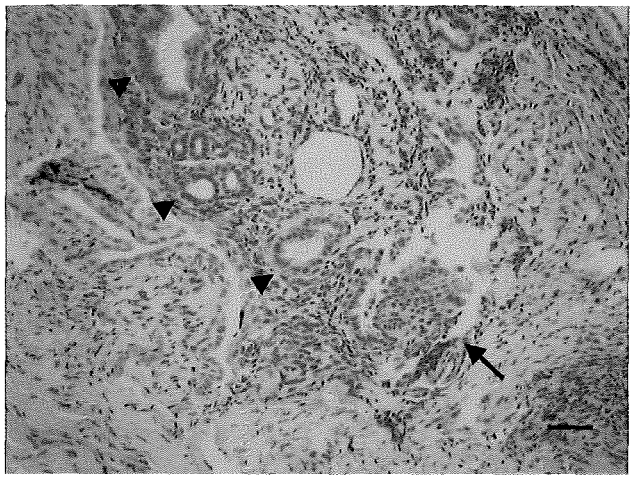

Figure 6. Photomicrograph of subdural mass from a 5-year-old intact male Staffordshire terrier with hindleg paresis. A proliferating population of cells is arranged in solid sheets and in poorly-organised, variably-sized tubules which are lined with cuboidal to attenuated epithelium (arrowheads). A solid tuft of cells, reminiscent of an embryonic glomerulus, is projecting into the lumen of an epithelium-lined cavity (arrow). Overall, the tissue is forming a poorly-demarcated mass which is invading the surrounding fibrous connective tissue. The diagnosis was spinal nephroblastoma. Hematoxylin and eosin stain, bar = 50 µm.

Radiation therapy was recommended however this is not available locally and the owners were restricted financially. The dog recovered temporarily and had almost returned to normal ambulation three weeks following surgery with voluntary urination and defecation. Four weeks after surgery, the dog showed left hind leg lameness and clinical signs associated with back pain. The dog was managed with tramadol (2.2 mg/kg PO twice to three times daily). Four months following diagnosis, the dog had become increasingly lethargic and ataxic. This was considered most likely due to tumour growth although this was not confirmed via diagnostic imaging. Four and a half months after surgery, the dog's pain could not be managed with oral medication and the dog developed faecal incontinence. The owner requested euthanasia of the dog at this time.

DISCUSSION

Several diagnostic options are available to the practitioner when evaluating a dog with neurologic disease. The choice of diagnostic test is guided by an assessment of the dog's neurologic examination and signalment. Evaluation of CSF is most useful for diagnosing inflammatory disease of the central nervous system.[2] Elevated CSF protein concentrations without inflammatory cells are seen primary degenerative diseases, neoplasia, infarction, or central nervous system compression.[2] Tumour cells may be observed in the CSF in some neoplastic lesions if the tumour is exfoliative and adjacent to the subarachnoid space, for example lymphoma.[2] As in this case, many dogs with spinal nephroblastoma have unremarkable CSF evaluation.[3]

Diagnostic imaging is able to precisely localise the lesion and refine the differential diagnosis list. Spinal cord tumours are classified according to their location as extradural, intradural extramedullary (outside the spinal cord), or intramedullary (within the spinal cord). Intramedullary tumors are rare, constituting only 15% of all spinal neoplasia.[4] Spinal radiographs are evaluated for changes in the intervertebral disc space and lysis of the vertebral column. Advanced imaging is typically required to fully characterise the spinal lesion. Advanced imaging options include myelogram, CT and magnetic resonance imaging (MRI). A diagnostic myelogram (radiographs) can typically differentiate between a compressive extradural, intradural extramedullary, or intramedullary lesion.[2] Radiographs and or CT can be performed after myelogram injection (contrast material injected into the subarachnoid space). Further imaging with CT or MRI, both pre and post intravenous contrast injection, is used to confirm a suspected lesion that cannot be identified definitively on radiographic or CT myelogram. The primary benefit of CT is that it allows for three dimensional reconstruction and imaging without superimposition of other structures. Because CT uses similar x-ray technology as radiographs it is ideal for evaluation of bone detail. Both CT myelogram and CT with intravenous contrast was used in this dog. The myelogram was difficult to interpret due to contrast also flowing into the epidural space. Intravenous contrast accumulates in areas of high blood flow such as a neoplastic growth or inflammation. Intravenous contrast with CT imaging allowed for precise identification of the spinal tumour in this dog. Magnetic resonance images are generated through a computer-assisted technique that measures the magnetic property of tissues.[2] Magnetic resonance imaging provides better soft tissue visualization of the central nervous system compared to CT. The preferred diagnostic imaging for this dog would have been MRI however it was not readily available.

Nephroblastomas are embryonal neoplasms that arise from primitive metanephric blastema.[3] During embryonic development, the metanephric blastema differentiates into epithelial and stromal components to form the kidney.[3] Cells that do not undergo differentiation eventually undergo apoptosis.[3] Spinal nephroblastomas are thought to originate from neoplastic transformation of the metanephric blastema or from a persistent nephrogenic nest that becomes trapped in the dura during development.[3] Spinal nephroblastomas are typically found between the tenth thoracic and the second or third lumbar vertebrae and are most commonly intradural extramedullary

tumours.[3,5] Intramedullary nephroblastomas, as was seen in this dog, are uncommon.[3,5] Affected dogs are typically young, ranging in age from five months and five years (median age between 14 months and 2 years) in two case studies.[3,5] Surgical excision of the tumour can provide alleviation of clinical signs. This is most commonly performed for tumours in an intradural extramedullary location. Radiation therapy can be used alone or following cytoreductive surgery.[5] Survival times of dogs with intradural extramedullary nephroblasoma are longer (estimated median survival 380 days, range 176-560 days) than dogs with confirmed intramedullary nephroblastoma (estimated median survival 140 days, range 38-269 days).[5] This is comparable to what was seen in this dog with a survival time from diagnosis of four and a half months.

Several differential diagnoses must be considered when evaluating a dog with neurologic disease. With careful neurologic examination and lesion localisation, a systematic approach to diagnostics will allow a definitive diagnosis to be made. This allows for appropriate recommendations for treatment and accurate prognostication.

ACKNOWLEDGEMENTS

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