Received: 25 July 2024 | Revised: 15 October 2024 | Accepted: 16 December 2024

DOI: 10.1002/vrc2.1074

Vet Record CaseReports

CASE REPORT

Companion or pet animals

Meningeal solitary fibrous tumour (hemangiopericytoma) in a dog

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Abstract

A 6-year-old, male entire French Bulldog was presented for a 2-month history of progressive ambulatory tetraparesis and occasional cervical pain. Neurological examination was consistent with a right-sided C1–C5 myelopathy. Magnetic resonance imaging revealed an intradural-extramedullary mass over the C1–C2 vertebrae. The mass was surgically excised, and histopathological examination demonstrated a neoplastic vascular proliferation within a fibrous-myxoid stroma. Immunohistochemical staining allowed further characterisation of the lesion, which was consistent with a solitary fibrous tumour (hemangiopericytoma). The patient improved neurologically after surgery. This type of tumour had not been previously reported in dogs in this location.

BACKGROUND

Spinal diseases are a frequent complaint in clinical practice. Many different processes can affect the spinal cord, thus a good history, general physical examination and complete neurological examination are essential to localise the lesion in the nervous system and to make a differential diagnosis list based on the epidemiological and clinical features present in each patient.[1] Neoplasms affecting the spinal cord and adjacent structures are frequent causes of myelopathies.[2]

Spinal neoplasms are classified according to their location as follows: extradural neoplasms that arise primarily from structures surrounding the duramater, intradural-extramedullary neoplasms that grow within the dura but outside the spinal cord, and intradural neoplasms that grow primarily within the spinal cord. Extradural neoplasms are the most frequent neoplasms in small animals (up to 50%), and they include primary and secondary osseous tumours, haemangiosarcoma, multiple myeloma or lymphoma, among others. Intradural-extramedullary neoplasms account for 35% of spinal neoplasms, and meningiomas are the most frequent ones in this group. Meningiomas are also the most frequently diagnosed primary neoplasms of the central nervous system (CNS) in dogs and cats. Intramedullary neoplasms are about 15% of all spinal neoplasms in dogs, and ependymomas and gliomas are the most frequent ones in this group.[3]

This report describes the case of a dog with ambulatory tetraparesis caused by a solitary fibrous tumour (SFT) affecting the cervical spinal cord. The tumour was classified as a perivascular wall tumour, formerly called hemangiopericytoma (HPC). To the authors' knowledge, reported cases in veterinary medicine of this type of neoplasm are restricted to the skin, joints, liver and muscle of the retroperitoneal space, but no reports of this tumour have been found in a meningeal location.[4–6] In addition, this case report discusses the differential diagnoses of the magnetic resonance images and highlights the need of immunohistochemistry techniques to reach a definitive diagnosis.

CASE PRESENTATION

A 6-year-old, entire, male French Bulldog presented to the Veterinary Teaching Hospital of the Autonomous University of Barcelona, with a 2-month history of progressive ambulatory tetraparesis and occasional cervical pain that was noticeable when eating or walking downstairs. General physical examination was unremarkable. Neurological examination showed ambulatory tetraparesis and proprioceptive ataxia of all four limbs. Proprioceptive positioning was absent in the right and reduced in the left limbs. Segmental spinal reflexes were intact. Upon spinal manipulation, there was resistance

to cervical ventroflexion. The rest of the neurological examination was unremarkable. Neuroanatomical localisation was a right C1–C5 myelopathy, and main differential diagnoses included intervertebral disc disease/extrusion, neoplasia and inflammatory/infectious processes.

INVESTIGATIONS

Complete blood cell count and serum biochemistry were unremarkable. Thoracic radiographs revealed spondylosis deformans of the vertebral bodies of T7–T8, T11–T12 and L1–L2. Abdominal ultrasound was unremarkable.

Low-field magnetic resonance imaging (MRI) of the cervical vertebral column revealed a rounded intradural-extramedullary mass located on the right dorso-cranial aspect of the vertebral body of C2 in the vertebral canal. The mass was hyperintense on T2-weighted (T2W) and isointense on T1-weighted (T1W) images, and enhanced strongly after contrast administration (gadoteric acid, 0.1 mmol/kg bodyweight; Dotarem, Guerbet). It had well-defined margins (length 1.4 cm × height 9.8 mm × width 12.3 mm) and occupied approximately 98% of the diameter of the vertebral canal causing severe spinal cord compression (Figure 1). A cerebrospinal fluid (CSF) sample was obtained by lumbar puncture and CSF analysis revealed a total nucleated cell count within reference range (3 nucleated cells/μL; reference range, <5 nucleated cells/μL) and mildly elevated total protein concentration (0.78 g/L; reference range, <0.45 g/L).

DIFFERENTIAL DIAGNOSIS

Based on the clinical and imaging findings, a presumptive diagnosis of intradural-extramedullary neoplasia (meningioma, peripheral nerve sheath tumour, perineurioma, haemangioblastoma, haemangiosarcoma or histiocytic sarcoma) was made, although an inflammatory/infectious granuloma or a unilateral chronic hypertrophic ganglioneuritis were also considered.

TREATMENT

A right-sided hemidorsal laminectomy was performed over the C1–C2 vertebrae. Special care was taken to preserve the dorsal atlanto-axial ligament to avoid creating joint instability, as well as the transverse foramen of the atlas to preserve the vertebral artery and vein. Upon opening the vertebral canal, the spinal cord appeared enlarged by the presence of an intradural mass. With the help of a #11 scalpel blade, a durotomy was performed to expose the mass. CSF leakage and bleeding were observed just after durotomy. Careful dissection of the mass was performed with the aid of Rothon microdissectors. A nodular, greyish mass of approximately 1 cm in diameter, irregular and of solid consistency was carefully dissected from the subarachnoid space and submitted for histopathological analysis. The patient recovered uneventfully from the surgical procedure and was discharged 5 days after surgery.

LEARNING POINTS/TAKE-HOME MESSAGES

- Spinal neoplasm must be considered in dogs with a history of chronic and progressive myelopathy.
- Differential diagnoses for intradural-extramedullary spinal masses with homogeneous contrast enhancement include meningioma, peripheral nerve sheath tumour, perineurioma, haemangioblastoma haemangiosarcoma, unilateral chronic hypertrophic ganglioneuritis and solitary fibrous tumour (hemangiopericytoma).
- Histopathology and immunohistochemistry techniques are the gold standard for the definitive diagnosis of these neoplasms.

OUTCOME AND FOLLOW-UP

Routine histopathological examination with haematoxylin–eosin revealed a nodular, non-encapsulated but well-circumscribed neoplasm composed of a staghorn-vascular pattern and streams of abundant interstitial fibrous-myxoid stroma. The neoplastic cells were spindle-shaped and had a moderately eosinophilic cytoplasm, undefined cell borders and a central round to oval nuclei with stippled chromatin. Cellular and nuclear pleomorphism was mild and the mitotic count was low (0–1 mitosis/0.237 mm^2). Aggregates of perivascular lymphocytes and plasma cells and small areas of dystrophic mineralisation were observed. No necrotic areas or haemorrhages were identified in the different sections. In the periphery of the neoplastic proliferation,

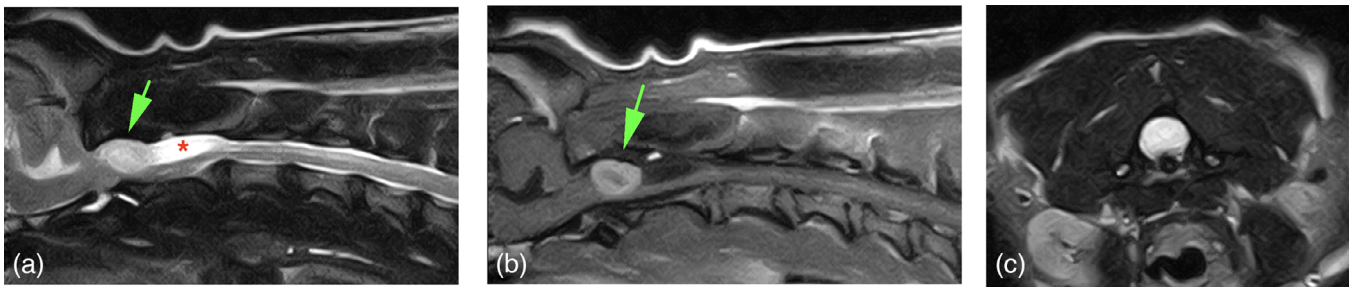

FIGURE 1 Magnetic resonance imaging of the cervical spine including T2W sagittal (a), T1W post-contrast sagittal (b) and T1W post-contrast transverse (c) sequences showing an intradural-extramedullary (golf-tee sign, asterisk) mass rostral to the vertebral body of C2 (green arrow), hyperintense on T2 and with marked homogeneous contrast enhancement.

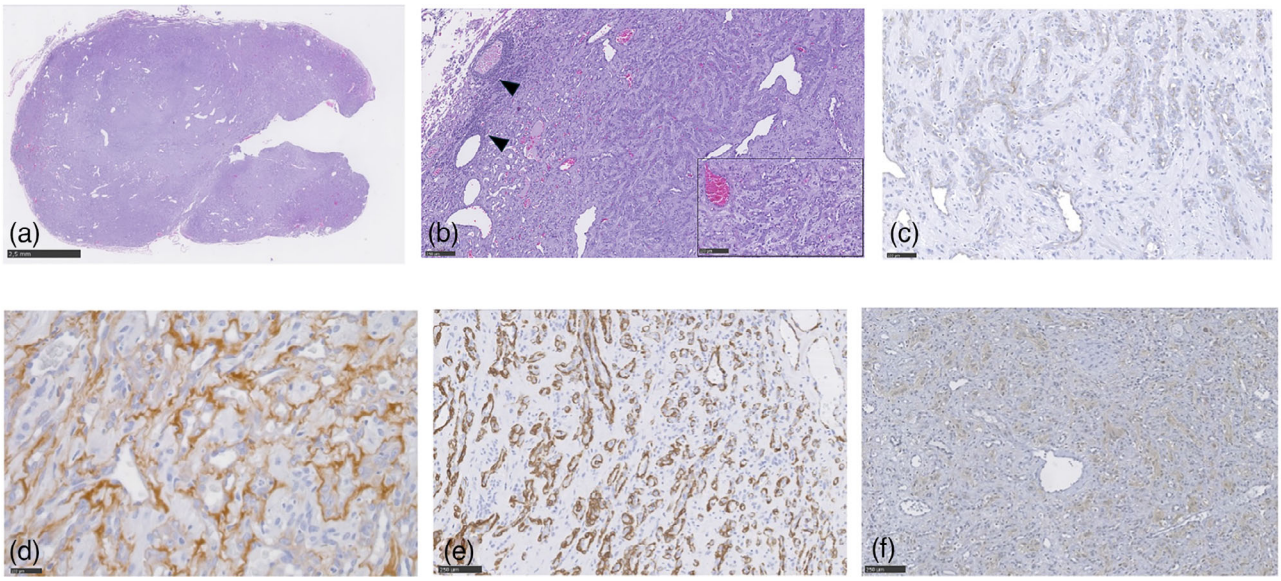

FIGURE 2 (a and b) Haematoxylin and eosin staining: (a) Nodular proliferation, well-demarcated, non-encapsulated neoplastic. (b) Staghorn-vascular pattern and streams on abundant interstitial fibrous-myxoid stroma (arrowhead), and perivascular lymphocytes and plasma cells in the periphery (inset). Spindle-shaped neoplastic cells, with round to oval nuclei and mild mitotic activity and low pleomorphism. (C–F) Immunohistochemical staining: (c) CD31: expression in non-neoplastic endothelial cells. (d) Laminin: strong immune reaction lining the endothelial proliferation. (e) SMA: strong immune reaction of neoplastic perivascular proliferation cells. (F) SOX10: mild to moderate protein expression in interstitial fibrous-myxoid stroma. Original magnification: A: ×0.75; B: ×10 (inset ×20); C and D: ×20; E and F: ×10.

scants of myelinated nerve fibres (probably from a nerve root) were seen (Figure 2A,B).

A panel of immunohistochemical (IHC) stainings including epithelial membrane antigen (EMA) (1:40, Mouse, Dako M0613), CD31 (1:20, Mouse, Dako M0823), laminin (1:800, Rabbit, Dako Z0097), vimentin (1:200, Mouse, Dako M0725), smooth muscle actin (SMA) (1:500, Mouse, Dako M0851), desmin (1:100, Mouse, Dako M0760), SOX10 (1:100, Mouse, Sigma SAB1402361), and Protein Gene product 9.5 (PGP9.5) (1:1800, Rabbit, RA95101 Ultraclone) were performed. Secondary antibodies were used *PoliStain 1-step kit, HRP for DAB, Mouse, no chromogen, NB-23-00029-1, NeoBiotech* and PoliStain *1-step kit, HRP for DAB, Rabbit, no chromogen, NB-23-00030-1, NeoBiotech*.

The IHC study revealed strong positivity of the neoplastic staghorn pattern cells for SMA and minimal for desmin. The interstitial fibrous-myxoid stroma was positive for vimentin, PGP 9.5 and Sox10. The basal membrane and endothelial cells were positive for laminin and CD31, respectively. Immunostaining for EMA was negative (Figure 2C–F). Based on all the data from the histological and IHC study, a final diagnosis of meningeal intradural SFT (HPC) was reached.

The patient was periodically rechecked, and 3 months after surgery only a mild tetraparesis was noted on neurological examination. Adjuvant treatment with chemotherapy and radiotherapy was offered to the tutors, but it was declined for financial reasons. Ten months after surgery, a follow-up MRI was performed and no evidence of tumour recurrence was observed (Figure 3).

DISCUSSION

The findings described in this case report are consistent with a meningeal SFT, a non-meningothelial mesenchymal neoplasm originating from the pericytes of meningeal blood capillaries, not previously described in dogs. Pericytes, first described by Ebeth (1871) and Rouget (1873), are elongated mesenchymal cells that coil around and along endothelial cells. They are thought to be multipotent cells, and therefore have multiple functions, such as structural support for the capillary wall, phagocytosis, regulation of angiogenesis and contraction of capillary smooth muscle cells, among others. Pericytes are also believed to be precursor cells for microglia, smooth muscle cells, osteoblasts and chondroblasts, and adipocytes.[4,5]

SFT of the CNS, previously named and classified as HPC, is a rare neoplasm and accounts for less than 1% of all intracranial tumours in human beings.[6] Studies about the overall incidence of this neoplasm in the spinal cord are scarce. According to the human classification, there are three types and five subtypes of spinal HPC based on their location: type I or extradural tumours (IA: intracanal, IB: extracanal), type II or intradural tumours (IIA: extramedullary, IIB: intramedullary) and type III or intradural tumours with extension into the extradural and paravertebral areas.[7] In the new World Health Organization classification of CNS neoplasms,[8] the previously combined entity SFT/HPC is no longer used. The term SFT includes now both entities, which share very similar morphopathological features and are difficult to differentiate. In turn, this tumour is classified into three different grades according to its malignant characteristics. Using the human classification proposed above, the neoplasm described here would be an SFT grade 2 type IIA.

Several studies in human medicine suggest that this type of primary CNS sarcoma can mimic other types of benign or malignant spindle cell neoplasms, especially meningiomas. Initially, it was considered to be an angioblastic variant of meningioma, and it was not until 1952 that Begg and Garret proposed a new classification differentiating the formerly

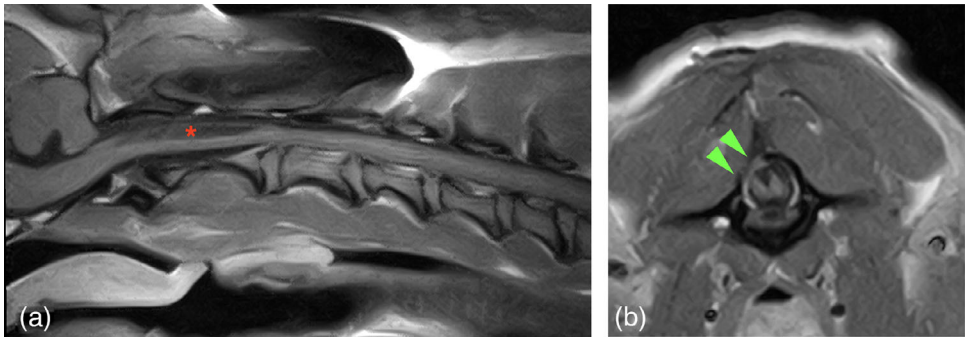

FIGURE 3 Follow-up magnetic resonance imaging of the cervical spine showing no evidence of relapse of the mass. T1W post-contrast sagittal (a) and transverse (b) images. Mild syringomyelia (red asterisk) can be observed over the vertebral body of C2, probably secondary to spinal cord atrophy due to the presence of the mass, which may have caused parenchymal necrosis. An incidental finding linked to patient's breed should also be considered. The lack of the right dorsal lamina on the site of the hemidorsal laminectomy is observed (green arrowheads).

named HPC as an independent entity unrelated to meningiomas. Other possible differential diagnoses for SFTs are schwannomas and fibrosarcomas.[9–11]

In order to diagnose and classify this rare neoplasm, IHC techniques were necessary. SMA, a marker that stains smooth muscle in the perivascular capillaries, did stain positively because of the smooth muscle precursor characteristics of pericytes. This was supported by the subsequent positivity for desmin, which is a marker of intermediate filaments in the intracellular cytoskeleton of muscle cells. Concomitant positivity for PGP 9.5 and Sox10 was observed in a mild and diffuse form throughout the tumour stroma. These markers are frequently used to identify cells originating from the neural crest, but it was recently discovered that they can also mark other tissues unrelated to the nervous system.[12–16]

According to the human literature, SFTs in the spinal cord and brain have a high index of recurrence and metastases, and these are more likely in more malignant tumours.[8] Primary SFTs of the spinal cord most commonly metastasise to the lungs, brain, bone and other spinal cord sites.[13,17] In the case described here, no metastases were identified in lungs, brain or bones on the MRI or radiographic studies performed. Advanced imaging of the thoracolumbar spine or the limb bones was not performed, so the possibility of metastasis was not completely ruled out, but it seems unlikely considering the absence of clinical signs at diagnosis and 1 year after surgery.

No data have been found in the veterinary literature regarding the prognosis of this type of tumour in the CNS. In the case described here, no signs of relapse could be observed in the MRI performed 10 months after surgery, so excisional biopsy seems to be an adequate treatment option for this type of neoplasm. Likewise, the benefit of post-surgical adjuvant treatment is unknown because the owner declined further treatment options.

The MRI findings were consistent with other processes (neoplastic or inflammatory) as discussed above. Considering the cervical location of the mass and its characteristics (single lesion with well-defined margins and homogenous contrast enhancement), the main differential diagnosis were meningioma, malignant peripheral sheath tumour or chronic unilateral hypertrophic ganglioneuritis.[18] However, the absence of dural tail sign, the lack of C2 spinal nerve root enlargement or widening of the intervertebral foramen ipsilateral to the lesion and the lack of changes in the surrounding musculature made these differential diagnoses less likely.[19] Although rare in veterinary medicine, other neoplasms such as haemangioblastoma, haemangiosarcoma, histiocytic sarcoma or perineurioma have also been described as primary tumours affecting the spinal cord and nerves, and were considered in this case because of the similar MRI characteristics.[20–23]

Finally, disturbance of the blood–spinal barrier in neoplasms affecting the meninges and obstruction of the normal CSF flow through the subarachnoid space secondary to the mass effect produced by the lesion have been reported to cause an increase in total protein concentration in the CSF.[24]

In conclusion, this case report describes the first case of meningeal intradural SFT (HPC) in dogs. This neoplasm should be considered as a differential diagnosis in cases of meningeal masses, and highlights the importance of advanced imaging tests and immunohistochemistry techniques to elucidate the neoplastic origin.

AUTHOR CONTRIBUTIONS

Alejandro Comesaña: managed the case and drafted the manuscript. **Sonia Añor** and **Cristian de la Fuente**: supervised the management of the case and revised the manuscript critically for important intellectual content. **Martí Pumarola** and **Jaume Alomar**: interpreted histopathology samples and revised the manuscript critically for important intellectual content.

ACKNOWLEDGEMENTS

We gratefully acknowledge Ester Blasco and Tamara Rivero for technical assistance.

CONFLICT OF INTEREST STATEMENT

The authors declare they have no conflicts of interest.

ETHICS STATEMENT

All investigations were planned with the owner's consent. As this is a case report, no ethical approval was needed. According to the journal's author guidelines page, the authors confirm compliance with the journal's ethical policies.

FUNDING INFORMATION

The authors received no specific funding for this work.

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How to cite this article: Comesaña A, Alomar J, Pumarola M, Fuente C, Añor S. Meningeal solitary fibrous tumour (hemangiopericytoma) in a dog. Vet Rec Case Rep. 2025;e1074.
https://doi.org/10.1002/vrc2.1074