Mesenchymal Tumour Arising from within a Canine Spinal Cord Hamartoma Features

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Abstract

A five-year-old male castrated Jack Russell Terrier was presented for cervical pain and left thoracic limb lameness of one-year duration. Magnetic Resonance Imaging (MRI) revealed a 1.1 x 0.7 x 0.8 cm lesion at the level of the seventh cervical spinal nerve with infiltration into the spinal cord. Surgical removal was elected, and all visible tumour was excised. Histopathology was supportive of a mesenchymal tumour consistent with components of both a fibrolipomatous hamartoma, proximally and a peripheral nerve sheath tumour distally. Radiation Therapy (RT) was elected post-operatively. MRI was repeated for RT planning one-month post-operatively and for recurrence of symptoms ten months post-operatively. This is the only report in literature to document a mixed tumour characteristic of both a fibrolipomatous hamartoma and peripheral nerve sheath tumour, and only the second case report to document surgical exploration of a hamartoma in the canine spinal canal.

Keywords: Spinal cord; Peripheral nerve; Neurolocalization; Mesenchymal; Surgical treatment; Radiation therapy

Introduction

This case report describes the clinical progression, imaging findings, surgical treatment, and post-surgical imaging of a mixed hamartoma and peripheral nerve sheath tumour in the canine spinal cord. Due to the lack of knowledge regarding hamartomas of the canine nervous system, this case provides new information to the limited number of reports. This report is also unique due to the mixed tumour characteristics identified at histopathology as well as post-operative follow-up.

Case Study

A five-year-old male castrated Jack Russell Terrier was referred to the North Carolina State University (NCSU) Neurology Service in May of 2019 for surgical treatment of a spinal mass at the level of 7th cervical spinal nerve with infiltration into the spinal cord from the left noted on MRI performed at a local specialty hospital. The patient had a progressive one-year history of cervical pain and left thoracic limb lameness that worsened over the few months leading up to his MRI diagnosis. On presentation to NCSU, the initial exam revealed a mild left thoracic limb lameness with normal postural reactions and slightly decreased strength of withdrawal in the left thoracic limb. Mild cervical pain was elicited on palpation, and there was a reduced range of motion in the cervical region. The remainder of the physical and neurologic exams were unremarkable. Neurolocalization was consistent with a C6-T2 myelopathy. The previously performed MRI revealed a 1.1 x 0.7 x 0.8 cm extramedullary, possibly intradural, a mass lesion within the left aspect of the vertebral canal. The mass extended from the level between the 6th and 7th cervical vertebrae,

spanned approximately 50% of the canal's width, and extended peripherally into the C6-C7 intervertebral foramen and 2 cm distal following the normal course of the C7 nerve root (Figures 1a and 1b). The variation in signal intensity of the vertebral canal mass characteristics consistent with fat, hemorrhage , and contrast-enhancing tissue. Neoplasia was strongly suspected, with differentials including liposarcoma, round cell neoplasia, and hemorrhagic meningioma. Cerebrospinal fluid obtained at the time of the MRI revealed a mild lymphocytic pleocytosis.

A modified dorsal hemilaminectomy was performed at C6-7. The patient was placed in sternal recumbency with his head moderately flexed ventrally. The dorsal cervical area was prepped and draped. A left dorsal approach was made to the cervical vertebrae with the nuchal ligament positioned to the right of the midline to allow the paraspinal muscles to be reflected from the spinal column from C5 to T1. A left dorsal hemilaminectomy was performed over C6-7 and extended laterally to expose the left C7 nerve root. The extradural and intradural mass was identified

at the level of the C7 nerve root **(Figure 2)**. A durotomy was performed over C6-7, which exposed the tumour extending along with the spinal nerve roots, with extension into the adjacent spinal cord parenchyma. The mass was moderately adhered to the dura ventrally and mildly adhered to the spinal cord parenchyma. The visible tumour extended peripherally along the C7 spinal nerve to the level about 2 cm ventral to the vertebral artery. At this distal extent, the nerve texture grossly palpated and resembled that of a typical normal spinal nerve. The C7 nerve was transected at the level of the grossly normal nerve so that visible mass was removed and submitted for histopathology. The spinal cord was decompressed with no obvious damage to the vertebral artery. The closure was routine. The patient recovered well and was managed with IV, oral pain medications, and a single intraforaminal injection of bupivacaine and methylprednisolone administered at the level of C6-7 the day after surgery. At discharge, six days after surgery, the patient had mild pain on cervical manipulation and was non-ambulatory hemiparetic on the left side. At home, medical management consisted of cage rest and pain control medications.
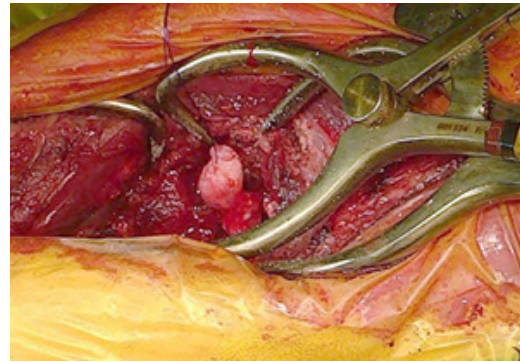

Figure 1a: Sagittal magnetic resonance image (T2-weighted; TR, 2,500 milliseconds; TE, 130 milliseconds) of the cervical and cranial thoracic portion of the vertebral column of a dog examined due to left forelimb lameness and cervical pain. There is a focal hyperintense mass lesion of the spinal cord at the level of the C6-C7 spinal nerve, with infiltration into the spinal canal.

Figure 1b: Transverse magnetic resonance images (T1-Axial FAT SAT Post); TR, 525 milliseconds; TE, 20 milliseconds) of the dog in **Figure 1** at the C6-C7 level.

Figure 2: Gross intraoperative appearance of the C6-7 spinal mass. The proximal portion of the mass (top of image, white portion of mass with suture in place) was consistent histologically with a fibrolipomatous hamartoma, while the more distal portion (bottom of image, red portion of mass) was most consistent with a peripheral nerve sheath tumour.
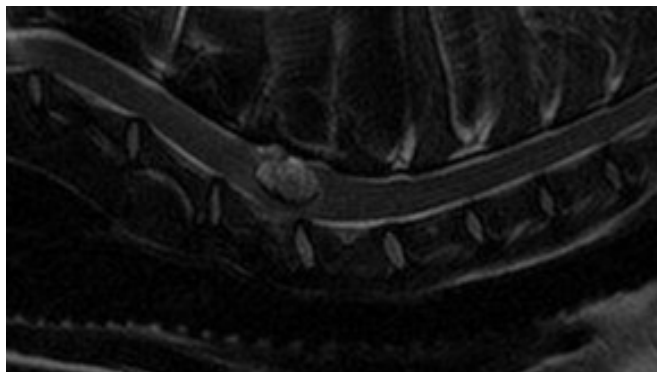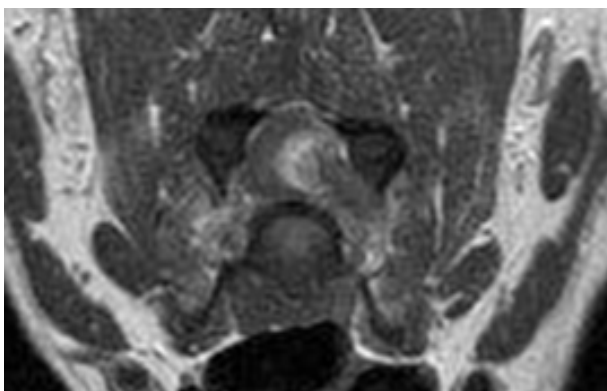
Histopathologic features of the mass were consistent with a mesenchymal tumour arising in a fibrolipomatous hamartoma. Microscopically, the main portion of the mass was composed of dense mature fibrous connective tissue that separated and surrounded lobules of mature adipose tissue **(Figure 3A)** and was punctuated by many variably sized mature arterioles **(Figure 3B)**. The fibrovascular tissue extended into the nerve root, peripheralizing and compressing the ganglion and degenerative axons against the perineurium. As the mass travelled along the nerve, it became progressively more disorganized with looser interwoven bundles and streams of fusiform cells resting in eosinophilic fibrillar stroma separated by clear space **(Figures 3C and 3D)**. The fusiform cells exhibited minimal anisocytosis and anisokaryosis, and nuclei were elongated with coarsely clumped chromatin **(Figure 3E)**. Mitotic figures were not visualized. Compressed between this mass and the surrounding perineurium were streams of hypertrophied and hyperplastic Schwann cells with rare isolated dilated myelin sheaths with fragmented globules of myelin indicative of myelin degeneration. Occasional aggregates of lymphocytes, plasma cells, and macrophages were scattered throughout these regions. Given the histologic features and anatomic location, the mesenchymal neoplasm component of the mass was considered most consistent with a peripheral nerve sheath tumour.

One month later, the patient represented to NCSU for RT to possibly slow the progression of tumour regrowth and increase survival time. At that visit, the patient was ambulatory with left-sided hemiparesis. Mild general postural reaction deficits were noted in the left thoracic limb and left pelvic limb. An MRI and computerized Tomography (CT) was performed for RT planning. The MRI revealed the bulk of the prior mass lesion at the level of the left C6-7 intervertebral foramen and C7 nerve root had been excised. The intervertebral foramen was widened at this level, reflecting the surgical removal of portions of the left-sided pedicles and C6-7 articular process. There were multiple foci of susceptibility artifact continuing dorsally to the subcutaneous tissue and skin consistent with the previous surgical incision. The spinal cord was displaced left laterally at the level of the C6-7

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foramen. The spinal cord otherwise appeared to be of normal intensity with no obvious compression. Regional lymph nodes included in the view were normal. No evidence of macroscopic disease was identified.
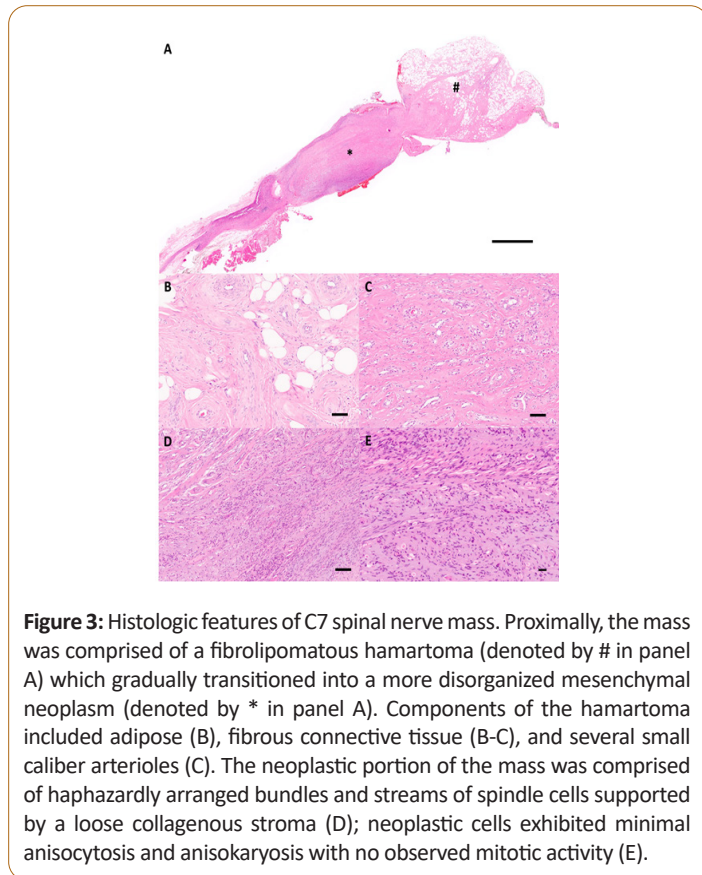

Figure 3: Histologic features of C7 spinal nerve mass. Proximally, the mass was comprised of a fibrolipomatous hamartoma (denoted by # in panel A) which gradually transitioned into a more disorganized mesenchymal neoplasm (denoted by * in panel A). Components of the hamartoma included adipose (B), fibrous connective tissue (B-C), and several small caliber arterioles (C). The neoplastic portion of the mass was comprised of haphazardly arranged bundles and streams of spindle cells supported by a loose collagenous stroma (D); neoplastic cells exhibited minimal anisocytosis and anisokaryosis with no observed mitotic activity (E).

Radiation Therapy (RT) was scheduled to start approximately one month after surgery, but prior to starting treatment, the patient developed nausea and lethargy. Bloodwork revealed elevated hepatic enzymes, elevated bilirubin, and elevations in amylase and lipase. An abdominal ultrasound was performed. Diagnostics were considered consistent with acute pancreatitis. The patient improved with supportive care. Definitive RT (52.5 Gy total dose, 25 daily 2.1 Gy fractions) was instituted approximately 2-months after surgery. A 3D conformational RT plan and 6 MV photons were utilized along with daily image guidance (4 planning hours). The patient did not have any significant side effects other than mild coughing, suspected tracheitis secondary to RT, and skin irritation at the site of the radiation field. The patient was treated throughout with gabapentin for mild cervical pain.

Six months postoperatively, the patient returned for a recheck MRI. The owner reported the patient's mobility improved, but he remained painful in his cervical region. A neurologic exam revealed an ambulatory left hemiparesis with mild to moderate left thoracic limb lameness. Postural reactions were delayed in the left thoracic limb and absent in the left pelvic limb. Moderate pain on caudal cervical palpation was present. The MRI revealed changes consistent with the prior surgical removal of portions of the left-sided pedicles and C6-7 articular process and surgical incision. The MRI also indicated marked osseous and fibrotic tissue

proliferation at the surgical site and adhesion of this tissue to the adjacent spinal cord **(Figure 4)**. No evidence of gross neoplasia or metastatic disease was present. The spinal cord itself was focally expanded from the level of C5-6 to C7-T1 with mild dilation of the central canal. At C6-7, the left portion of the spinal cord was mildly hyperintense on T2 relative to the rest of the spinal cord.
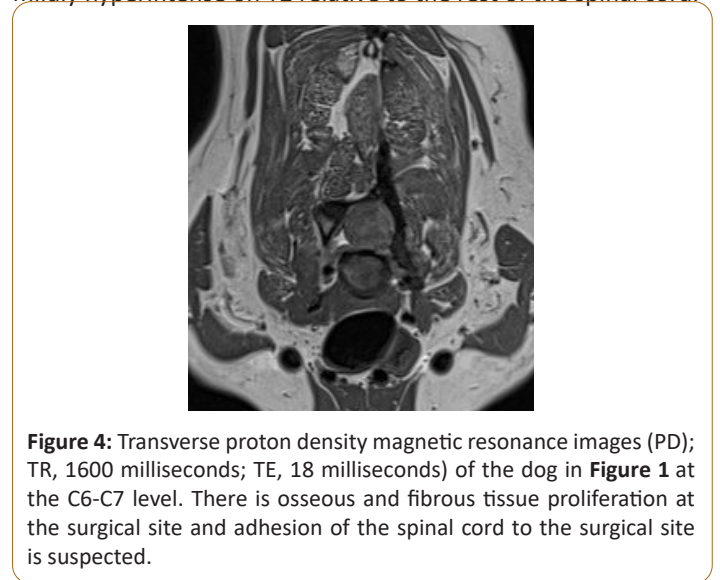

Figure 4: Transverse proton density magnetic resonance images (PD); TR, 1600 milliseconds; TE, 18 milliseconds) of the dog in **Figure 1** at the C6-C7 level. There is osseous and fibrous tissue proliferation at the surgical site and adhesion of the spinal cord to the surgical site is suspected.

Eleven months postoperatively, the patient exhibited increased pain and difficulty ambulating. An MRI was performed and was supportive of tumour regrowth. The patient was euthanized three months later due to a further decline in his clinical condition. A necropsy was not performed.

Discussion

Hamartomas are congenital overgrowths of tissue elements found in the organ from which they arise. Although they are generally considered benign anomalies, they can cause secondary effects due to compression. This has led to their description as a link between malformations and neoplasia [1]. Previous reports on canine hamartomas have documented their presence in vascular, mesenchymal, muscular, and cutaneous adnexal tissue. Within the nervous system, the vast majority are vascular in origin [2]. While cerebral vascular hamartomas have been reported multiple times in the canine veterinary literature only one report currently exists documenting a vascular hamartoma within the spinal cord [1,3]. Additionally, a single report documents a cranial nerve hamartoma [2]. There are no reports which describe transformation into a peripheral nerve sheath tumour.

Treatment of hamartomas depends on the location and tissue involved. While they are common in the skin of dogs, they are rarely reported affecting the central or peripheral nervous system in canine patients [1,4]. One previous case report revealed a hamartoma at the level of T6 and suggested that surgical removal of hamartomas is recommended for improvement of neurologic deficits; however, the diagnosis is not made prior to surgery [1]. MRI is the imaging modality of choice in identifying spinal cord disease. However, presently MRI is not able to applicably distinguish neoplasms from hamartomas [1,5].

Tumours of the paraspinal peripheral nerves have previously been classified with inconsistent terminology. The current WHO designation adapted for veterinary use includes four major subtypes: schwannoma, neurofibroma, perineurioma, and malignant peripheral nerve sheath tumour (PNST) [6]. PNST histologic characteristics include a high cell density of pleomorphic spindle cells with characteristics of malignancy [6]. They originate from Schwann cells, endoneurial fibroblast cells, and epineurial fibroblast cells close to the axial skeleton [6]. A retrospective study further classified PNST of the tract C6-T2 into subcategories based on their location. These categories include "peripheral" if nerves distal to the plexus are involved, "of the plexus" if the brachial plexus is involved and the emerging nerves from C5 to T2 distal to the intervertebral foramina, or "of the roots" if involving the dorsal or ventral roots. [7,8].

Peripheral Nerve Sheath Tumours (PNST) typically occur in dogs older than five years and cause ipsilateral neurologic deficits and pain [7,9,10]. Common features include local invasion of soft tissue or metastasis [10]. Treatment depends on the location of the tumour. Surgical excision, with or without RT, has anecdotally been described as the treatment of choice; however, new literature suggests that RT alone may provide similar benefits [11]. In one retrospective study, the Median Survival Time (MST) for dogs affected by root tumours was 150 days, with recurrence occurring in 78% of cases [9]. A recent prospective study assessing frameless stereotactic radiation as a sole method of treatment for brachial plexus and root tumours found that local recurrence occurred in 90% of dogs treated with volumetric modulated arc radiation therapy. MST was 371 days, and progression-free survival was 240 days [11]. Although this study only assessed 10 dogs, seven of which had root involvement, the results showed improvement in the quality of life and expectancy when compared with previous literature [11]. Apart from this recent study, a lack of information exists in determining which treatment for peripheral nerve sheath tumours is superior. Previous literature suggests that prognosis ultimately depends on the location of the tumour (nerve root vs. plexus) and whether or not the tumour is malignant [12-16]. The regrowth of the tumour noted on MRI prior to necropsy suggests that it was likely PNST as recurrence is common with this tumour type [9,11,17].

Spinal cord hamartomas are rarely reported in the veterinary literature. Few patients have been diagnosed with a hamartoma of the central nervous system, and of these reports, none of the cases developed an associated secondary neoplasia. This case provides the first description of a hamartoma arising from within a canine spinal cord exhibiting possible malignant transformation to a peripheral nerve sheath tumour. The unique histopathologic characteristics of the tumour were the most striking aspects of this case, but the pronounced bony regrowth post-operatively was also noteworthy. It is currently unknown if the degree of bony regrowth was related to the type of tumour or if it was caused by a separate aetiology. There are currently no characteristics defined which predispose canine patients to more pronounced regrowth; residual neurologic deficits (residual lameness and pain) may have been explained by the scar tissue in the region of the regrowth and its adhesion to the cord.

Conclusion

Additional post-operative follow-up data regarding clinical outcome and repeat MRI was useful to document the tumour regrowth characteristics and long-term prognosis. Necropsy, a biopsy, and histopathology of the regrowth would have provided further insight into the case. Further study is warranted to classify hamartomas in canine species, especially in the nervous system.

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