Malignant Peripheral Nerve Sheath Tumor arising from the Spinal Canal in a Cat

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ABSTRACT. A 10-year-old female mongrel cat with back pain was brought to the Nihon University Animal Medical Center. Palpation demonstrated a mass in the back region. Radiography revealed partial destruction of the processus spinosus and the arch of the T8 and T9 vertebrae. On magnetic resonance imaging, the mass was found to have compressed the spinal cord and extended to the outside of the spinal canal. We performed extirpation of the mass, and confirmed that it arose from the spinal canal. Histopathologically, the mass was a malignant peripheral nerve sheath tumor.

KEY WORDS: feline, malignant peripheral nerve sheath tumor, MRI.

There is considerable confusion concerning the nomenclature of tumors deriving from the peripheral nerve sheath. Histologically, such tumors are classified into categories of benign peripheral nerve sheath tumors (schwannoma and neurofibroma) and malignant peripheral nerve sheath tumors (malignant schwannoma and neurofibrosarcoma) [8]. There have been relatively few studies on feline peripheral nerve sheath tumors arising from the spinal canal, and malignant cases of this tumor are even rarer [1, 8, 9, 19]. We encountered a cat with a malignant peripheral nerve sheath tumor arising from the spinal canal. We evaluated the clinical signs, radiography and magnetic resonance imaging (MRI) findings, surgery, and postoperative course.

A 10-year-old female mongrel cat, weighing 2.14 kg, with back pain was brought to the Nihon University Animal Medical Center. The cat had been unhealthy with anorexia and constipation for 1 month, and was taken to a local veterinarian. The cat had suffered from back pain for 1 week. A mass was detected in the region of the back, and the cat was referred to our hospital for diagnosis and treatment.

On initial examination, the body temperature was 40.3°C, and the heart and respiratory rates were 212/min and 40/min, respectively. Hematological examination demonstrated slight increases in liver enzyme levels (alanine aminotransferase, 156 U/L; aspartate aminotransferase, 116 U/L). Neurologically, the cat could walk, and all postural reactions were within the normal ranges. Spinal reflexes and deep pain were normal in both the thoracic and pelvic limbs. The cranial nerves were normal. Radiography revealed partial destruction of the T8 vertebral processus spinosus on the caudal side, T9 vertebral processus spinosus on the cranial side and T9 vertebral arch, between which hyperlucency was observed (Fig. 1).

MRI (FlexArt, Toshiba, Tokyo, 1.5T) demonstrated a mass, measuring about 2.5–3 cm, on the back of the T8–9 vertebrae. T1-weighted imaging (TR=500 msec, TE=15 msec, FA 90°, NAQ 1) of the mass showed isointensity compared to the spinal cord (Fig. 2A), and T2-weighted imaging (TR=4,500 msec, TE=105 msec, FA 80°, NAQ 1) showed a mixture of hypo-, iso-, and hyper-intensities (Fig. 2B). The mass was unevenly enhanced by Gd-DTPA-enhanced T1-weighted imaging (Figs. 2C and D). The mass compressed the spinal cord from the right and extended to the outside of the spinal canal.

To perform extirpation of the mass, we exposed the spinal column from T4 to T13 by a dorsal approach. The processus spinosus and the arch of the T8 and T9 vertebral were partially destroyed. The mass covered with a capsula was solitary in the space between T8 and T9. We observed adhesion of the mass to the dura mater. The dorsal mass was removed by lasing it from the dura mater. We lysed the adhesions between the mass and the surrounding tissue, and removed the remaining mass by dividing the dorsal and ventral areas. The vertebral bodies were immobilized using pins and wire.

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Fig. 1. Lateral radiograph. Bone destruction of the T8 vertebral processus spinosus on the caudal side and T9 vertebral processus spinosus on the cranial side and arch was observed (arrow heads).
The mass, covered with a pellucid capsula, was white and soft, and the boundary was clear (Fig. 3). The cat had a good post-surgical prognosis. Adjunctive therapies were not performed because of the owner’s circumstances, but this cat had periodic medical examination. However, the cat was brought back to our hospital in the 10th month after surgery due to back pain. We confirmed that the cat did not have pulmonary metastasis, and performed MRI examination and myelography. Examinations revealed that an extradural mass had compressed the spinal cord from the right side, which we diagnosed as a relapse of the tumor. The tumor was thus removed using an approach similar to the previous occasion. Two months after the secondary surgery, the postoperative course was positive, although mild palsy remained in the right pelvic limb, and no pain was observed.

Histologically, there were areas of densely proliferated spindle-shaped to oval cells arranged in a fasciculated or whorled pattern, suggestive of the Antoni A pattern of schwannoma, and areas with cartilaginous metaplasia or mucoid differentiation in loosely cellular sheets (Figs. 4A and 4B). The tumor cells showed bone invasion where osteoclasts were present, indicating bone resorption. Furthermore, the cells had aggressively infiltrated into the muscular layer. The tumor cells had fibrillar, eosinophilic cytoplasm, ill-defined cell borders, and elongated nuclei with coarsely clumped chromatin. A few mitotic figures were present throughout the fields.

The nuclei and cytoplasm of the neoplastic cells were immunoreactive for S-100 protein (Fig. 5), while the vimentin antibody was strongly reactive in the cellular cytoplasm. Peripheral nerve sheath tumors were classified into three anatomical groups by Brehm [2]. The Peripheral Group included tumors involving nerves distal to the brachial or lumbosacral plexus [2]. The Plexus Group included tumors involving nerves of the brachial or lumbosacral plexus and those of the spinal nerves distal to the intervertebral foramina [2]. The Root Group included tumors involving the dor-
sal or ventral nerve roots and any tumors entering intervertebral foramina [2]. The tumor could not be classified before surgery, because it was outgrowing. However, we observed that the mass was located in the spinal canal at surgery, and compressed the spinal cord. In addition, the tumor entered the intervertebral foramina. Therefore, we speculated that the mass was classified into the Root Group, and the origin was the spinal nerve root involving the spinal canal.

With regard to feline nerve sheath tumors, periocular peripheral nerve sheath tumor [10], schwannoma abdominal mass [14], nerve sheath tumor in the cervical and lumbar vertebrae [11], and neurolemmoma in the thoracic vertebrae [22] have been reported. There have been reports on malignant peripheral nerve sheath tumors in the cranial, inguinal, and subcutaneous regions and under the skin of thoracic limbs [14, 16, 19]. We observed the tumor arising from the spinal canal at surgery. Our case is classified into the extradural tumor in the spinal tumor. There have been only 3 previous cases of cats with peripheral nerve sheath tumors arising from the spinal canal based on past reports [11, 22]. There were two cases of extradural tumors, and one of an intradural-extradural tumor respectively. The relapse of the tumor involved a single case of the previous three reported cases. The survival time was 70 days in the case of a cat featured in a past report [11], while in our case, the cat relapsed 10 months after surgery. We speculated that the extended period before the relapse was because the tumor had almost been removed.

Metastases of malignant peripheral nerve sheath tumors to lungs have been reported in dogs, while in goats, this tumor in the thoracic vertebrae developed systemic metastases [3, 9, 18, 20, 22]. Among tumors in the nervous system, the malignant peripheral nerve sheath tumor is rare in cats, and there have been no reports on its metastasis [1, 2, 8, 9, 19]. In our case, the tumor revealed a malignant histopathology, but no metastasis was detected two months after the second surgery.

Radiography of malignant peripheral nerve sheath tumors extended to the outside of the spinal canal in dogs, cats, and humans and bone destruction was indicated [4, 5, 12, 15, 21, 22]. In our case, however, bone destruction was observed in the processus spinosus and the vertebral arch, in line with past studies. The mass extended to the outside of the spinal canal from the destroyed vertebral arch.

There have been no studies on the observation of feline malignant peripheral nerve sheath tumors arising from the spinal canal by MRI. However, a malignant canine peripheral nerve sheath tumor has been reported, of which T1-weighted imaging showed isointensity compared to the surrounding muscles, and T2-weighted imaging showed hyperintensity. The tumor was unevenly enhanced by Gd-DTPA-enhanced T1-weighted imaging [7]. Similar MRI findings in a malignant canine peripheral nerve sheath tumor in the mid-diaphysis of the left humerus have been reported [13]. In human peripheral nerve sheath tumors, T1-weighted imaging showed isointensity compared to the spinal cord in

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**Fig. 4.** Fusiform tumor cells were densely packed and formed interwoven bundles (A). Cartilaginous metaplasia was present in a portion of the tumor mass (B). (H&E, bar = 80 µm).

**Fig. 5.** Nuclei and cytoplasm of the neoplastic cells were immunoreactive for S-100 protein (bar = 40 µm).
75% of patients and hypointensity in 25%, while T2-weighted imaging showed hyperintensity in 95%, of whom about half showed a target appearance, in which a hypointensity region due to collagen and myxomatous degeneration could be observed in the tumor center. The tumor was unevenly enhanced in more than half of the patients by contrast media [6, 12, 15, 17]. In our case, T1-weighted imaging showed isointensity, as in dogs and humans. However, T2-weighted imaging showed a mixture of hypo-, iso-, and hyper-intensities, unlike that in dogs. It was speculated that the region in which myxomatous degeneration was pathohistologically observed appeared as hypoor iso-intensity. We confirmed that the mass extended to the outside of the spinal canal on transverse images. Surroundings of the spinal cord presented hyperintense on the transverse T2-weighted images, and the boundary of the spinal cord and the tumor was clear. We could not confirm the nerve roots from the MRI and it is normally difficult to do so, because the spinal cord and nerve root are small in a cats. We encountered considerable difficulty in confirming the nerve root with the tumor on MRI. During surgery, we were unable to find the nerve root with the tumor, due to the severe destruction of part of the tumor and surrounding tissue.

To our knowledge, there has been neither a report on a malignant peripheral nerve sheath tumor from the spinal canal in felines nor any study involving MRI observation of such a tumor. The present findings of a malignant peripheral nerve sheath arising tumor in a cat, similar to humans, will be diagnostically useful.

REFERENCES