NOTE *Surgery*

Magnetic Resonance Imaging and Computed Tomography Findings of Vertebral Osteosarcoma in a Cat

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ABSTRACT. An 8-year-old female Persian cat with a gait disorder was brought to our hospital. Pelvic limb mobility had gradually reduced over the preceding 3 months, then rapidly deteriorated 2 weeks before consultation. Signs also occurred in the thoracic limbs. With a tentative diagnosis of neural disease, magnetic resonance imaging and computed tomography were performed. T1-weighted imaging showed isointensity in the seventh cervical vertebra, while T2-weighted imaging revealed hypointensity. Contrast-enhanced T1-weighted imaging revealed a uniformly enhancing mass. Extirpation of the mass relieved the clinical signs, leading to disappearance of the neurological signs. The histopathological examination suggested osteosarcoma.

KEY WORDS: computed tomography (CT), feline, magnetic resonance imaging (MRI), spinal osteosarcoma.

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The diagnosis of spinal tumors is more difficult than that of tumors of the appendicular skeleton, because the radiographic diagnosis is difficult, and various diseases are suspected from the neurological signs. Radiologic evaluation of human patients who present with osseous vertebral lesions often includes radiography, computed tomography (CT), and magnetic resonance imaging (MRI). Because of the complex anatomy of the vertebrae, CT is more useful than conventional radiography for evaluating lesion location and analyzing bone destruction and condensation [18]. On the other hand, MRI has been found to be valuable in evaluating lesion location and volume, revealing tumor extent, defining its relationship with the vertebral canal, and showing tissue specificity [7, 21]. Moreover, a detailed differential diagnosis can be performed based on the MRI signal [10]. It has been suggested that early diagnosis of vertebral tumors (primary and metastatic) may improve survival [6].

Tumors rarely invade cat bones, with an estimated bone tumor incidence of 4.9/100,000 cats [5, 8]. Osteosarcoma accounts for approximately 70–80% of malignant primary bone tumors in cats, and it less frequently involves the axial skeleton than the appendicular skeleton [4, 8]. Only a few studies have reported vertebral osteosarcoma [11, 13, 16]. Few studies have reported MRI and CT findings for vertebral osteosarcoma, and more detailed data have not been reported [13].

We report herein the case of a cat with cervical vertebral osteosarcoma involving the epidural area and compressing the spinal cord. Surgery was performed after MRI and CT. In the present case, the postoperative course was good. To the best of our knowledge, the detailed findings of MRI or CT for vertebral osteosarcoma in cats have not been published. The clinical signs, imaging findings, and postoperative course for this case are presented.

An 8-year-old, neutered female Persian cat weighing 2.9 kg was brought to our hospital with a gait disorder. Ataxia of the pelvic limbs had developed and gradually deteriorated over the preceding 3 months. Signs had also been observed in the thoracic limbs, with rapid deterioration over the previous 2 weeks. On consultation, the cat's general condition was good. However, the right thoracic limb showed inversion. Hematological data were normal. The cat was negative for feline leukemia virus and feline immunodeficiency virus.

Neurological examination showed reduced postural reactions of the limbs and disappearance of the right radial carpal extensor reflex. Flexor reflexes of the limbs were normal. Cranial nerve testing yielded normal findings. The cat did not respond to administration of prednisolone.

Radiography, cerebrospinal fluid testing, MRI, and CT were performed at Nihon University Animal Medical Center. Examination of the cerebrospinal fluid was normal. Radiography revealed bone outgrowth involving the right vertebral body of the seventh cervical vertebra (Fig. 1). CT (Aquilion; Toshiba, Tokyo, Japan) showed proliferation of the right vertebral body of the seventh cervical vertebra and enlargement into the spinal canal. Calcification of the mass was confirmed. The border between the mass and the spinal cord was clear and ossified (Fig. 2), and the center of the mass was low density as compared with the remarkably ossified lesion. On MRI using a 1.5-T Flex-Art system (Toshiba), T1-weighted imaging (T1WI) (TR 380 msec, TE 15 msec) revealed an iso-intense mass compared to peripheral bone tissue (Fig. 3a). T2-weighted imaging (T2WI) (TR 3150 msec, TE 105 msec) showed a hypo-intense mass and an iso-intense spinal cord as compared with normal spi-

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Fig. 1. Plain ventrodorsal radiography shows bone outgrowth on the right side of the seventh cervical vertebra.

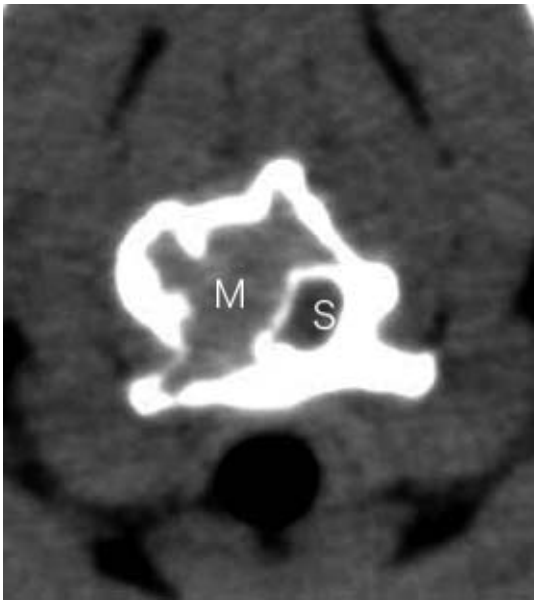

Fig. 2. Transverse computed tomography shows invasion to the spinal canal, compressing the spinal cord (S) from the right. The center of the mass shows low density as compared with the remarkably ossified lesion.

nal cord (Fig. 3b,c,d). The mass was uniformly enhanced on contrast-enhanced T1WI (TR 380 msec, TE 15 msec) (Fig. 3e). Furthermore, the mass had invaded the spinal canal from the right, compressing the spinal cord from this direction. Extirpation of the mass was performed using a dorsal approach. The proliferating bone lesion was resected using rongeurs. At the border between the mass and the spinal cord, outgrowth of periosteum-like tissue was observed. The center of the mass was soft, though the periphery of the mass was sclerotic. The mass was easily excised. After this periosteum-like tissue was resected, the spinal cord was exposed and gradually expanded. The vertebral body was then fixed with wire. The cat's gait was slightly improved by 2 days after surgery, and the gait became completely normal 2 weeks after surgery. The cat's postoperative survival time was 1.5 years, though its progress was uncertain because the owner moved. Histopathological examination suggested a tumor with proliferation of irregular- to spindle-shaped atypical cells. In the tumor cells, irregularly round to round-like atypical nuclei were noted. A large number of polynuclear giant cells were present. Clear cell nucleoli and cell divisions were observed. Osteoid tissue formation with calcareous deposition between tumor cells was frequent. Bone tissue formation was also noted at the tumor margin (Fig. 4a and b). These findings diagnosed osteosarcoma.

In this report, the imaging findings for radiography, MRI, and CT of vertebral osteosarcoma in a cat were described. The radiographic features of osteosarcoma in cats are variable. The associated bony lesions may be osteolytic, osteoblastic, or mixed change [19]. In appendicular osteosarcoma, osteolytic bony lesions tend to predominate; the bone often has a moth-eaten appearance [4, 19]. On the other hand, axial osteosarcoma has a more sclerotic appearance than its appendicular counterparts; however, lytic lesions are most often reported in vertebral osteosarcoma in cats [13, 16]. Radiography showed bone outgrowth of the seventh right cervical vertebra, which the authors believed was a lytic lesion. However, primary bone tumors include osteosarcoma, juxtacortical osteosarcoma, osteoma, osteoid osteoma, and chondrosarcoma [12]. Radiographic findings of bone tumors other than osteosarcoma frequently include bone outgrowth, but osteosarcoma also frequently shows bone lysis [4, 12, 13, 16]. In the present case, the diagnosis of osteosarcoma based on radiography was difficult, as bone outgrowth was apparent. Evaluation of tumor type or differentiation of tumor from inflammation is impossible on radiography [9]. While bone tumors may cross a disc space, this is rare, aiding in differentiation from discospondylitis [15]. On MRI after infusion of contrast medium, tumors or inflammatory lesions are enhanced, while inflammatory lesions are unevenly enhanced [1]. In the present case, the mass was uniformly enhanced after infusion of contrast medium, and the site of bone outgrowth was associated with a single mass on radiography. Thus, this lesion was considered to be a tumor.

In cats, a few vertebral/spinal tumors have been diagnosed based on MRI. Lymphoma, meningioma, peripheral

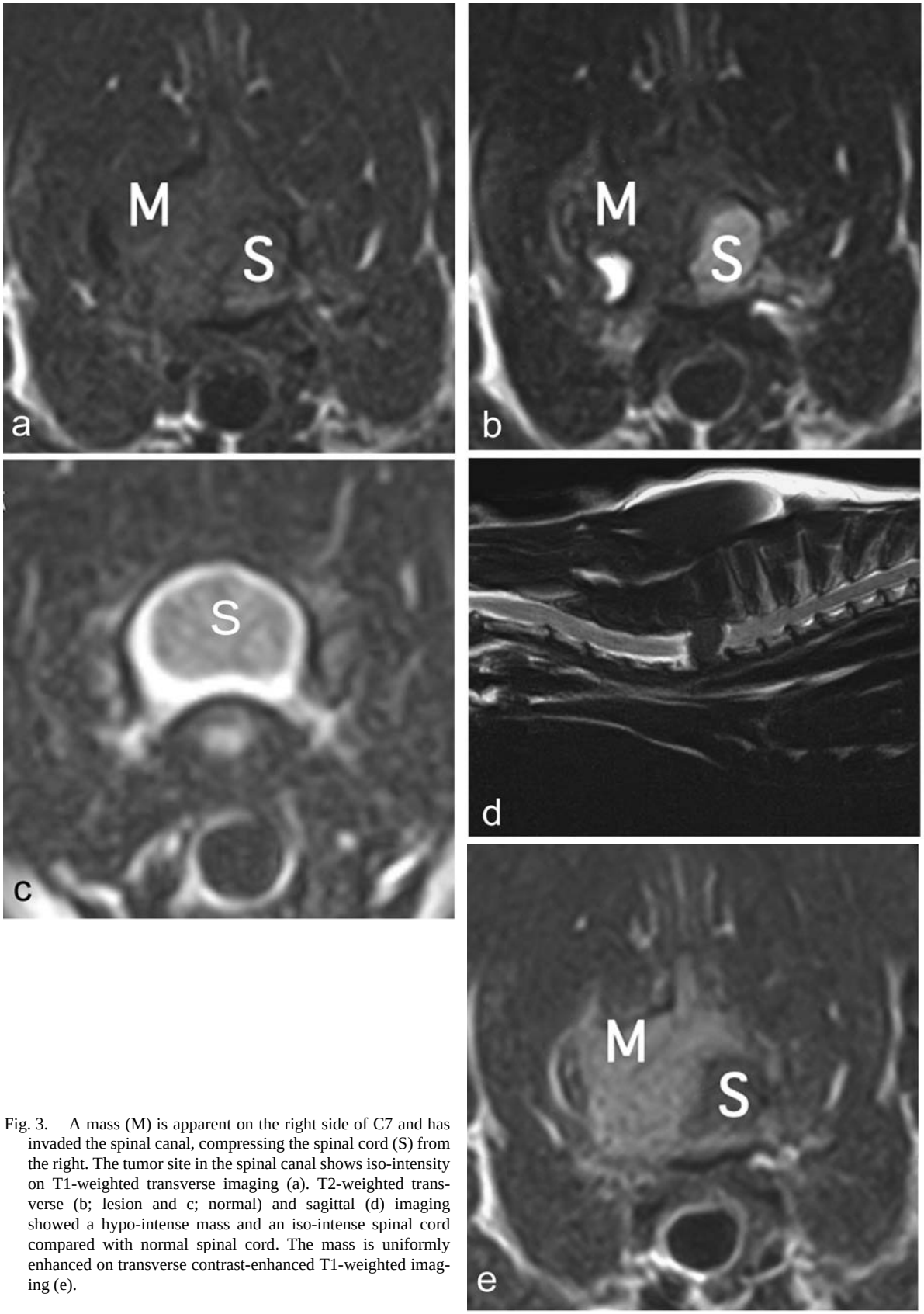

Fig. 3. A mass (M) is apparent on the right side of C7 and has invaded the spinal canal, compressing the spinal cord (S) from the right. The tumor site in the spinal canal shows iso-intensity on T1-weighted transverse imaging (a). T2-weighted transverse (b; lesion and c; normal) and sagittal (d) imaging showed a hypo-intense mass and an iso-intense spinal cord compared with normal spinal cord. The mass is uniformly enhanced on transverse contrast-enhanced T1-weighted imaging (e).

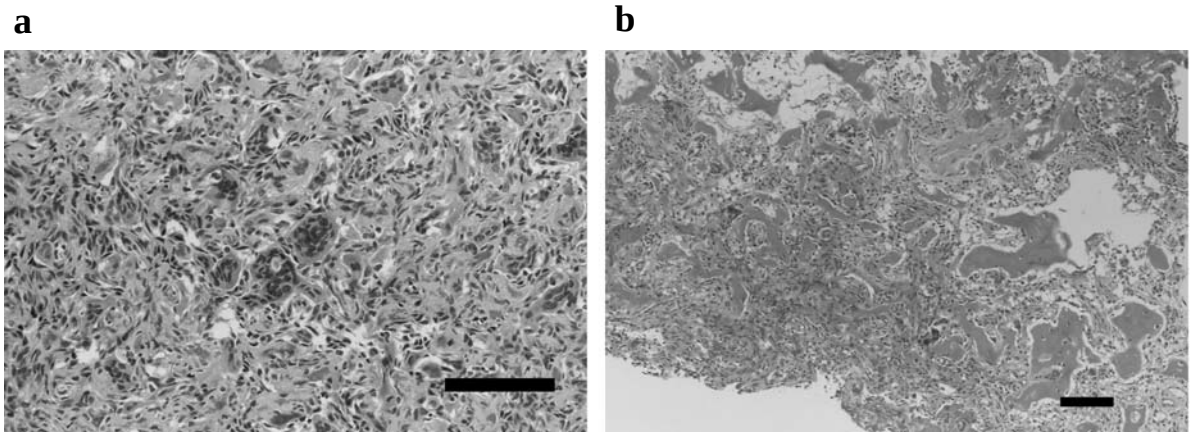

Fig. 4. Histopathology of the mass parenchyma. A large number of polynuclear tumor cells are seen at the center. These cells are irregular or spindle-shaped. Osteoid tissue with calcareous deposition is present between cells (a). (Hematoxylin and eosin. Bar=100 μm). Histopathology of the mass margin. A clear bone ridge-like structure is apparent between tumor cells (b). (Hematoxylin and eosin. Bar=100 μm)

nerve sheath tumor, plasma cell tumor, oligodendroglioma, and others have been reported [3, 13, 14, 17]. These tumors affecting the spinal cord were considered in the differential diagnosis of this cat that presented with neurological signs. Lymphoma in a cat has been reported as slightly hyperintense to gray matter on both T1WI and T2WI [14]. Meningioma reported in a cat shows no abnormalities on T1WI, slightly hyperintense on T2WI, and non-uniform enhancement with contrast medium [3]. A malignant peripheral nerve sheath tumor reported in a cat showed iso-intensity compared to the spinal cord on T1WI, a mixture of hypo-, iso-, and hyper-intensities on T2WI, and it was unevenly enhanced on Gd-DTPA-enhanced T1WI [17]. Spinal osteosarcoma in dogs reportedly shows iso- or hypo-intensity on T1WI, iso-intensity on T2WI, and non-uniform enhancement with contrast medium, which differs from the present case [10]. In the present cat, the osteosarcoma showed iso-intensity on T1WI and hypo-intensity on T2WI. The mass was uniformly enhanced on contrast-enhanced T1WI. In particular, the hypo-intense signal on T2WI is a characteristic finding, because many spinal tumors in cats do not show hypo-intensity on T2WI [3, 14, 17]. Moreover, osteosarcoma of domestic animals can be classified in greater detail histologically than on imaging, since the diagnosis of the histological subtype depends more on recognizing significant variations in the predominant matrix (osteoblastic, chondroblastic, and fibroblastic) [20]. It is considered that signal intensity can change in CT, such as low density at the cartilage, hemorrhage and necrosis, and high density at a lesion of mineralization. In the present case, it was thought that a mass with iso-intensity on T1WI may reflect the center of the mass showing low density as compared with the remarkably ossified lesion in CT. The lesion was found to be soft during surgical resection of the tumor, and it was consistent with the histological examination, in which the center of the mass was occupied by a high cellular density of osteoblasts with scanty osteoid. MRI signal intensity is usually nonspecific in humans with osteosarcoma of the spine [18]. Osteosarcoma in cats has various classifications in radiology and pathology. It may be difficult to diagnose with only an image of MRI signal intensity in cats because of nonspecific findings, as in human cases. Moreover, the authors confirmed that the tumor invaded or compressed the spinal cord in more than half of the vertebral canal on MRI, and there was no edema or inflammation in the area surrounding the spinal cord because of iso-intensity on T2WI. If inflammation and edema are present in the spinal cord adjacent to the tumor, the postoperative progress could be poor. In the present case, this information was presented to the cat's owner, and surgery was planned. The authors actually considered that the gait improved slightly 2 days after surgery because there was not inflammation and edema in the spinal cord. The advantage of MRI examination is that it can confirm the effects on the spinal cord and provide an evaluation of the surroundings of the tumor.

The lesion showed bone outgrowth on CT, as demonstrated on radiography. In dogs, CT excels in imaging tumors that destroy cortical bone [6, 15]. In 80% of vertebral osteosarcoma cases in humans, CT demonstrates matrix mineralization [18]. In the differential diagnosis with parosteal (juxtacortical) osteosarcoma, CT is useful particularly if it is unclear from radiographs whether the cortex is disrupted [19], because parosteal osteosarcoma does not disrupt the cortex and bone marrow of the underlying bone [2, 12]. In the present case, parosteal osteosarcoma had been ruled out based on the CT findings showing disrupted cortex. Moreover, mixed osteosarcoma became apparent in this case because of the center of the mass showing low density on CT, though it was difficult to diagnose on MRI and radiography.

The authors encountered a cat with osteosarcoma involving the cervical vertebrae that compressed the spinal cord. Detailed diagnosis, surgical planning, and evaluation of the prognosis based on the CT and MRI findings in this case

were discussed. As a result, we were able to recognize the clinical usefulness of CT and MRI. In cats, vertebral osteosarcoma is rare, and this report is the first case to describe the detailed MRI and CT findings of vertebral osteosarcoma.

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