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NOTE

Surgery

Infiltrative lipoma causing vertebral deformation and spinal cord compression in a dog

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ABSTRACT. A 4-year-old, male Bernese mountain dog was evaluated for a 1-year history of right hemiparesis. Computed tomography revealed a large hypoattenuating mass severely deforming the C5 vertebral arch, invading the C6 spinal canal, and causing spinal cord compression. The signal characteristics of magnetic resonance imaging indicated a lesion composed of adipose tissue. The mass was removed via right hemilaminectomy, and histopathological examination confirmed it was an infiltrative lipoma. The compressive lesion remained unresolved, so the dog underwent a second operation, after which he regained some ambulatory function. Although postoperative adjunctive radiation therapy was performed, the dog died 201 days after the first operation.

KEY WORDS: canine, infiltrative lipoma, osteoproliferation, spinal cord

Infiltrative lipoma is a mesenchymal neoplasm in which highly differentiated adipocytes infiltrate the surrounding tissues. It is derived from adipocytes in subcutaneous tissue or lipoma and is classified as a benign tumor because it rarely metastasizes to distant organs. However, infiltrative lipoma is more invasive than other lipomas, and it has been reported to invade adjacent tissues, such as muscles, connective tissues, bones, and rarely peripheral nerves and/or the spinal cord [2, 6]. Since the boundary between infiltrative lipoma and normal tissue is difficult to define, the reported rate of recurrence after aggressive surgical resection ranges from 36 to 50%. By comparison, after simple lipoma, the local recurrence rate can be as low as 2% [2, 6, 13]. In one study, the duration from surgical resection to recurrence was approximately 6 months, and the extent of tumor infiltration increased with each operation [14]. In addition, the growth rate of infiltrative lipoma is more rapid than that of lipoma [11]. For all these reasons, adjunctive chemotherapy and radiotherapy are recommended after surgical resection [8, 12].

It remains unclear why infiltrative lipoma exhibits more invasive behavior than simple lipoma despite being derived from the same adipocytes [2]. The present case report describes infiltrative lipoma in a dog that severely deformed a cervical vertebra and compressed the cervical spinal cord, causing cervical pain and quadriparesis.

A 4-year-old, castrated male, Bernese mountain dog weighing 31.9 kg was presented to the Animal Medical Center of Gifu University with a 1-year history of lameness of the right thoracic limb. The clinical sign had been recognized 1 year earlier, but had deteriorated rapidly 2 weeks before the hospital visit. A neurological examination revealed alert mental status and absent postural responses in the four limbs. The patient was recumbent and non-ambulatory. Spinal reflexes were hyperreflexic in all four limbs. Based on these findings, the neuroanatomical localization of the lesion was judged to be the C1–C5 spinal segment. There was no obvious restriction on the range of neck movement. Complete blood cell counts were within the normal limits, while blood biochemical examination showed slightly elevated alanine aminotransferase and alkaline phosphatase.

A radiographical examination of the neck revealed sclerotic changes around the C5–C6 intervertebral foramen (Fig. 1A). Computed tomography (CT) showed a homogeneous, hypoattenuating mass (mean HU value: −86.1) within the epaxial muscle on the right side of the C5 vertebral arch (Fig. 1B). This hypoattenuating mass encroached on the right C4–C5 intervertebral foramen, as well as the transverse foramen of C5, and extended into the spinal canal. In the spinal canal, at the level of C6, the mass severely compressed the spinal cord. The right vertebral arch of C5, which was in contact with the mass, was severely sclerotic and

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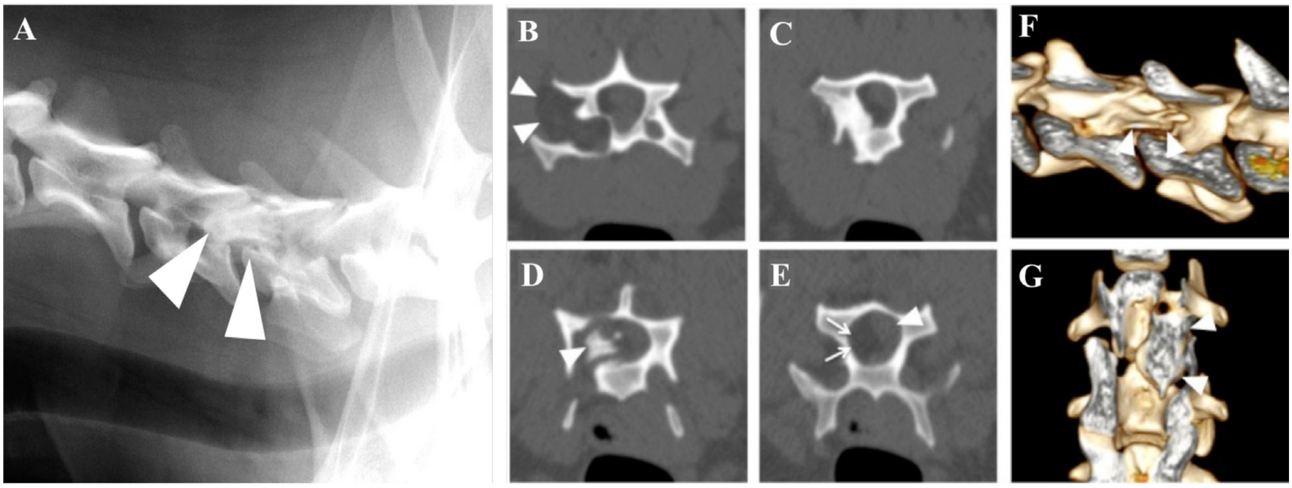

Fig. 1. Radiographic and computed tomography (CT) images of a 4-year-old Bernese mountain dog with lameness of the right thoracic limb. (A) Left-right lateral view. There is sclerotic change involving the C5–C6 intervertebral foramen (arrowheads). (B)–(G) CT images showing infiltrative lipoma characteristics and severe osteoproliferative change compressing the spinal cord. (B) A homogenous and hypoattenuating mass (arrowheads) invading the C5 transverse foramen. The CT value of the lesion was reminiscent of adipose tissue (mean HU value: −86.1). (C) The C5 right vertebral arch in contact with the lesion thickened and encroaching on the spinal canal. (D) Part of the deformed C5 vertebral arch (arrowhead) invading the C6 spinal canal and compressing the spinal cord. (E) The hypoattenuating mass (arrows) caudally invading the spinal canal and compressing the spinal cord (arrowhead). (F) An inside view of the midline sagittal 3D image of C5–C6 (left side of C5–C6 removed). The vertebral arch of C5 was deformed (arrowheads). (G) A dorsal 3D image of C5–C6. The C5 vertebral arch severely deformed and extending medially and caudally (arrowheads) (the dorsal half of the vertebral arches and spinal processes of C5–C6 were removed).

thickened (Fig. 1C). The caudal part of the C5 vertebral arch had deviated medially, invaded the C6 spinal canal, and compressed the spinal cord (Fig. 1D–G). Magnetic resonance imaging (MRI) revealed an inhomogeneous hyperintense mass on the T1- and T2-weighted images (Fig. 2A and 2B). No contrast enhancement of the lesion was observed (Fig. 2C). Under fat saturation, the signal intensity of the mass was markedly suppressed, indicating that the mass was composed of fat tissue (Fig. 2D). Based on these MRI signal characteristics, a tentative diagnosis of infiltrative lipoma was made. The dog underwent surgery to decompress the spinal cord.

After a dorsal midline approach was adopted, subcutaneous tissue and fat were bluntly detached. An incision was made in aponeurosis of the latissimus dorsi muscle at the midline, the nuchal ligament was exposed, and the right cervical muscle layer was incised between the nuchal ligament. The muscle was then peeled from the spinous process and lamina of the vertebral arch. The lesion appeared as white soft tissue on the right side of the fourth, fifth, and sixth cervical vertebral arches. To decompress the spinal cord, a right hemilaminectomy was performed from the caudal end of C4 to the cranial end of C6 using a high-speed drill system (Core console; Stryker, MI, U.S.A.). Visible lesions were removed using a cavitron ultrasonic surgical aspirator (Sonopet; Stryker). Since the boundaries between C5, the deformed vertebral arch, and the vertebral body were unclear, it was not possible to completely resect the lesion during the first operation. Histopathological examination of the removed tissue revealed that the lesion consisted of adipose cells of different sizes, fibrous connective tissue, and a small amount of cartilage tissue (Fig. 3). Arteries with a thickened, hyalinized intima and media were observed, and some of these were calcified. The histopathological diagnosis was infiltrative lipoma.

No improvements in motor function were observed in the paralytic limbs after the first surgery, and neck pain persisted. CT images obtained after the first operation demonstrated that the deformed vertebral arch of C5 still compressed the spinal cord, and that the mass lesion remained in the C6 spinal canal. This necessitated a second operation 6 days after the first one, during which a right extended hemilaminectomy was performed. The deformed left vertebral arch of C5 was removed more invasively, and the exposed mass lesion in C6 was excised as much as possible.

The neck pain resolved and the dog was able to stand up using both pelvic limbs and the left thoracic limb by 20 days after the second surgery. One month after the second surgery, he ambulated with three limbs. However, in the right thoracic limb, severe amyotrophy progressed and contracture was observed. Radiation therapy was initiated 32 days after the second operation, because the neoplasm was thought to have remained inside the C6 spinal canal. The caudal part of C4 to the cranial part of C6 was irradiated at a total dose of 40 Gy/six fractions once every 2 weeks for a total six times (Primus Mid-Energy; Canon Medical Systems, Tochigi, Japan). The dog's neck pain recurred 2 months after the final radiation therapy, at which point an MRI examination was performed. The results showed that the infiltrative lipoma had not recurred. However, diffuse hyperintensity on the T2-weighted images and fluid-attenuated inversion recovery images was observed from C2 to C6. A portion of the C3 spinal cord showed contrast enhancement. The number of cells in the cerebrospinal fluid (collected from the cisterna magna) was within normal limits, and no atypia was observed in the cells collected. Since both clinical signs and imaging studies suggested that a neoplastic lesion had

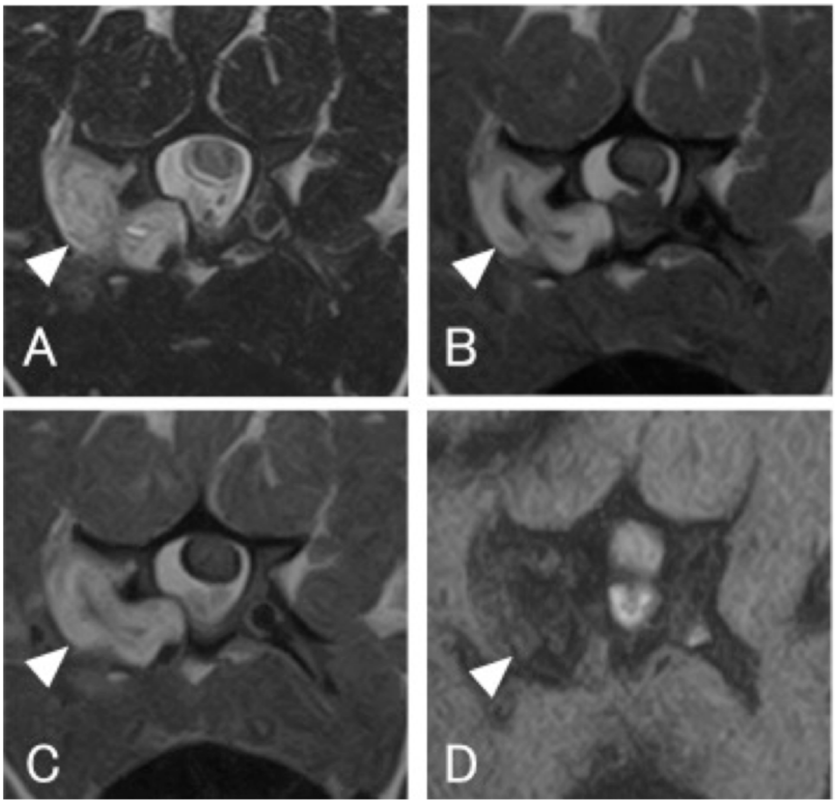

Fig. 2. Transverse magnetic resonance images of the vertebra and spinal cord at the C5 level. (A) T2-weighted image. A hyperintense mass (arrowhead) encroaching on the transverse foramen of C5. (B) T1-weighted image. The mass is characterized by a hyperintense area (arrowhead). (C) T1-weighted post-contrast image. There is no contrast enhancement of the lesion (arrowhead). (D) T2-weighted image with fat saturation (Spectral Adiabatic Inversion Recovery). The signal intensity of the lesion (arrowhead) is decreased to the same extent as the subcutaneous fat tissue. This image demonstrated that the lesion was composed of adipose tissue.

emerged that was different from the original infiltrative lipoma, additional radiation therapy (15 Gy/3 fractions) was initiated from the C2 to the cranial part of the C4 spinal cord. Despite these treatments, the neurological symptoms progressed, and the dog died 7 months after the second operation, most likely due to respiratory insufficiency. The owner declined necropsy.

Due to the invasive nature of this tumor [2, 6, 8], imaging techniques play an important role in assessing the shape, location, and extent of lesions, as well as in preoperative planning and planning for radiation therapy. In the present case, preoperative CT and MR images strongly indicated a lesion of adipose origin. Moreover, these imaging techniques were effective in detecting changes in the surrounding structures before surgery, such as hyperostosis and osteolysis of the vertebrae, and compression of the spinal cord.

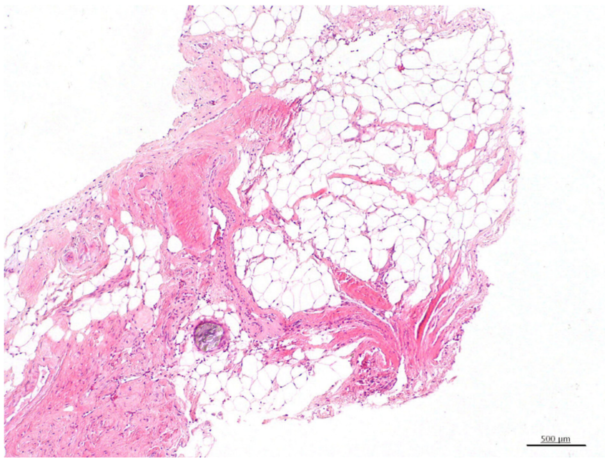

Fig. 3. Histopathological image of the removed tissue. Well-differentiated adipose cells and cartilage hyperplasia can be seen. A part of the artery is calcified (Hematoxylin and eosin staining; Scale bar=500 μm).

Although infiltrative lipomas can develop in any part of the body, those invading the spinal canal and compressing the spinal cord are relatively rare, with only four previous cases reported [1, 4, 5, 10]. In these past reports, the spinal cord was compressed by infiltrative lipoma that extended through the intervertebral foramen into the extradural space. Reports on infiltrative lipomas with secondary osteolysis of the adjacent bones are even rarer. McEntee *et al.* described 22 cases of infiltrative lipoma, 20 of which involved contact between the tumor and bones, whereas none showed evidence of either osteolytic or proliferative changes in the bones [8]. Invasion of infiltrative lipoma into the bones has only been reported in three dogs [5, 6]. The present case resembled that reported by Kim *et al.* [5] in terms of the tumor location and the osteolytic changes in the cervical vertebra. However, unlike Kim's case, the present case exhibited a massive osteoproliferative change in the C5 vertebral arch that encroached on and compressed the spinal cord. Thus, compression of the spinal cord was primarily caused by osteoproliferative changes in the vertebrae. The mechanisms underlying osteoproliferative changes caused by tumors have not yet been elucidated in detail; however, tumor-related hyperostosis has been associated with bone erosion caused by pressure atrophy and invasion of the Haversian canals by tumor cells, causing subsequent bone thickening [3, 9].

Radiation therapy may exert some effects on infiltrative lipoma [7, 8]. Conversely, the convoluted structure of the tumor, as well as secondary deformity of the vertebrae, make complete surgical removal of the tumor tissue difficult. In the present case, since it was not possible to completely resect the lesion in the C6 spinal canal, postoperative radiotherapy was performed. No local recurrence of the tumor was present approximately 7 months after the second operation. Thus, we judged that the present patient had benefited from the radiation therapy. However, 6 months after the second operation, MRI showed diffuse hyperintensity on the T2-weighted images and fluid-attenuated inversion recovery sequences from the C2–C6 spinal cord. Although we performed additional radiation therapy on these lesions, the patient's neurological symptoms deteriorated.

The present report describes a rare case of infiltrative lipoma with severe osteoproliferative changes in the cervical vertebrae. A radiolucent mass on plain radiographs, hypoattenuating lesion on CT, and a mass with a signal characteristic of fat on MRI, all suggested a lesion composed of adipose tissue. Osteolytic changes in adjacent bones may be an accompanying imaging finding; however, osteoproliferative changes can also co-exist with infiltrative lipomas.

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