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Magnetic Resonance Imaging Features of Suspected Acute Spinal Cord Infarction in Two Cats

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Abstract : Spinal cord infarction is becoming recognized as an important cause of acute myelopathy in cats. Although the definitive diagnosis is confirmed through postmortem histopathologic examination, MR imaging features provide valuable informations for the diagnosis of spinal cord infarction. The aim of this report is to describe MR findings of acute spinal cord infarction in two cats and to evaluate usefulness of low field MRI (0.3Tesla) as a potential diagnostic tool of acute spinal cord infarction. A cat (unknown age, neutered male mixed breed cat) was referred one day after the acute onset of non-ambulatory spastic tetraparesis and the other cat (a 9-year-old, neutered female domestic short hair cat) was presented due to the acute onset of non-ambulatory paraparesis and one day later paraplegia. The lesions of the MR images were shown on the spinal cord parenchyma over C2 to C6 in case 1 and L2 to L5 in case 2. The MR images in these two cases were characterized by focal intramedullary lesions, mainly involving grey matter which were hyperintense T2 weighted and FLAIR images and hyperintense on DWI and hypointense on ADC map. The MR findings in both cases were highly suggestive of acute spinal cord infarctions, based upon previous reported small animal cases and human cases. In conclusion, based on MR features, together with the history and clinical examination findings, MRI modality can be used as an antemortem tool for the diagnosis of acute spinal cord infarction in cats.

Key words **:** spinal cord infarction, cat, MR imaging, diagnosis.

Introduction

Acute spinal cord infarction is becoming recognized as an important cause of acute myelopathy in cats. Age at onset of signs has been reported between 4yrs and 12yrs and the majority was domestic short hair cats (14). Although spinal cord infarction can occur by many kinds of materials that obstruct the spinal blood supply such as thrombi or bacterial, parasitic, neoplastic or fat emboli, the most common cause of spinal cord infarction in cats is fibrous cartilaginous emboli (5). These materials of cause promote ischemic necrosis and result in spinal cord infarction ultimately. And predisposing factors for spinal cord infarction include cardiomyopathy, hypothyroidism, hyperthyroidism, hyperadrenocorticism and chronic renal failure (5). Because the definitive diagnosis is confirmed through postmortem histopathological examination, the diagnosis relies on the signalment, history, neurological signs, CSF analysis and MR features to distinguish it from other cause of acute myelopathy. The aim of this report is to describe MR findings of acute spinal cord infarction in two cats, to review advanced MR diagnostic criteria of acute spinal cord infarction and to evaluate usefulness of low field MRI (magnetic resonance imaging) as a potential diagnostic tool of acute spinal cord infarction.

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Case

Case 1

An unknown age, neutered male mixed breed cat was referred one day after the acute onset of non-ambulatory spastic tetraparesis with partial anorexia. The cat was housed indoors and had no history of trauma prior to the onset of clinical signs. Neurological examination revealed anisocoria and absent postural reactions in both hind limbs. The cat had no pain on palpation of cervical spine and thoracolumbar spine. And during physical examination voluntary urination was shown.

On blood analysis, there were mild decreased BUN (12.6 mg/dl, reference range: 15~34 mg/dl), mild decreased creatinine (0.6 mg/dl, reference range: 1.0~2.2 mg/dl), increased CPK (674U/L, reference range: 54~440U/L) and mild hyponatremia (144 mmol/L, reference range: 147~163 mmol/L) and mild hypokalemia (2.9 mEq/L, reference range: 3.7~5.2 mEq/L). And mild narrowed intervertebral disc space between the C4 and C5 was identified at cervical radiographic findings.

After several diagnostic tests, the localized lesions were the cervical spinal cord segments. After 2 days of hospitalization (3days after the clinical onset of symptoms), MRI

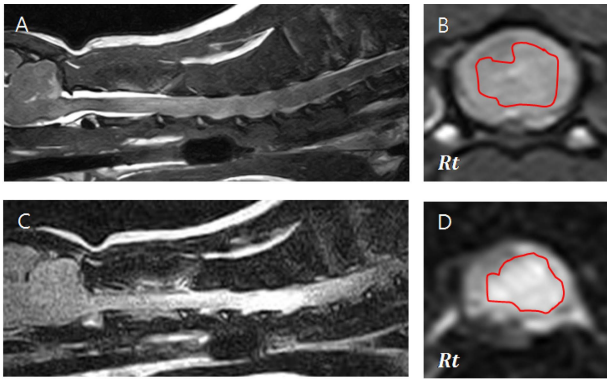

Fig 1. T1 weighted sagittal (A) and transverse (B) images and FLAIR sagittal (C) and transverse (D) images in case 1. These images show focal intramedullary hyperintense lesions, mainly involving left sided grey matter on the spinal cord over the C2 to C6.

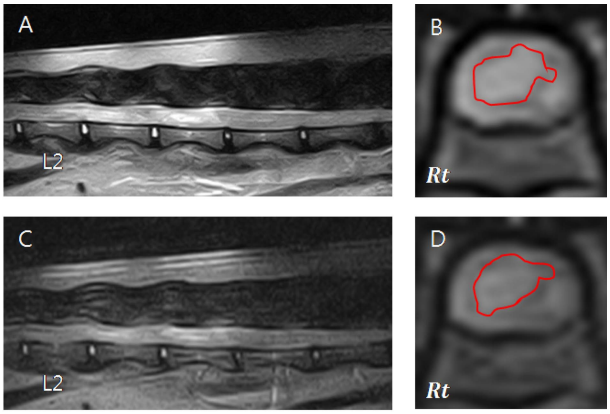

Fig 2. T1 weighted sagittal (A) and transverse (B) images and FLAIR sagittal (C) and transverse (D) images in case 2. The lesions are characterized by focal hyperintense intramedullary lesions on predominatly grey matter of spinal cord over the L2 vertebral body to L5 vertebral body without neural compression.

was performed using a 0.3T MR scanner in order to characterize the lesions and make a diagnosis. T2 weighted, FLAIR (fluid attenuation inversion recovery), DWI (diffusion weighted image), T1 weighted and post T1 weighted sequences following intravenous administration of Gd-DOTA (Dotarem®) at a concentration of 0.1 mmol/kg were used.

The lesions on the MR images were characterized by focal demarcated intramedullary lesions, mainly involving left sided grey matter on the spinal cord parenchyma over the C2 vertebral body to C6 vertebral body (Fig 1). And iso- to hyperintense signals on T1 weighted images and hyperintense signals on T2 weighted and FLAIR images were identified (Fig 1). There was no contrast enhancement on post T1 weighted images and hyperintense signals on DWI were appeared. There was no signs of cord compression.

Nextly CSF was obtained from cistern magna and was identified as normal. But the cat was treated with prednisolone succinate at local animal hospital, so this result was unreliable.

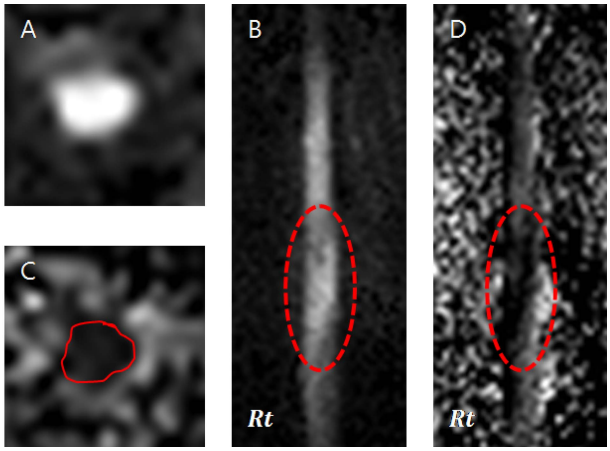

Fig 3. Transverse (A) and dorsal (B) DWI images and transverse (C) and dorsal (D) ADC images in case 2. High signal on DWI and low signal on ADC map are present on the lesions, consistent with restircted diffusion and spinal cord infarction.

After that, during hospitalization, prednisolone was administrated orally with tapering and intensive physical therapy was adjusted. Although remarkable neurological improvement was not identified, the owner reported that there was progressive improvement gradually two months later.

Case 2

A 9-year-old, neutered female domestic short hair cat was presented due to acute onset of non-ambulatory paraparesis and one day later paraplegia. The cat showed no history of trauma and no pain on palpation of the vertebral column.

On blood panel, mild increased ALT (136 U/L, reference range: 28~100 U/L), increased AST (450 U/L, reference range: 12~40 U/L), increased GGT (11 U/L, reference range: 0~10 U/L) and T. bilirubin (0.8 mg/dl, reference range: 0.1~0.4 mg/dl) were shown. Other blood analysis and abdominal ultrasonograhic findings were unremarkable. Lumbar spine radiographs revealed relatively narrowed IVD space between L4 and L5 and dorsal elevation of the thoracolumbar spine.

Based on radiographs and neurological exam, the localized lesions were lumbar spinal cord segments. MRI was performed one day after the clinical onset of symptoms using a 0.3T scanner for further evaluation. T2 weighted, FLAIR, GE (gradient echo), DWI, T1 weighted and post T1 weighted sequences following intravenous administration of Gd-DOTA (Dotarem®) at a concentration of 0.1 mmol/kg were used.

Focal demarcated intramedullary lesions, involved on predominantly grey matter over the L2 to L5 vertebral body without neural compression were found on MR images (Fig 2). And hyperintense signals on T2 weighted and FLAIR images were appeared as the MR features in case 1. The signals were hyperintense on DWI and hypointense on ADC (apparent diffusion coefficient) map (Fig 3). On GE sequence, focal hypointense signal lesions were found indicating a small quantity of hemorrhage.

After post-anesthetic recovery, the cat showed dyspnea, panting and severe depression. And the cat died two days later.

Discussion

Spinal cord infarction has two types, based on the onset of neurological signs, one is peracute form (< 6hrs), the other is acute form (< 24hrs) (17). Although the neurological clinical signs are variable depending on the severity and location of the ischemic lesion, the maximal neurologic clinical signs usually occur within the first 12-24hrs and the signs are improved and stabilized gradually (14). Rarely, for 48hrs the neurological deficit can progress because of secondary injury such as severe spinal cord ischemia, edema and malacia (14). So an acute onset of non-progressive (except for the first 48hrs), non-painful, usually asymmetric paresis is characteristic of spinal cord infarction (6). The prognosis on previous reports appeared poor, with 42% of cats being euthanased (13). But in recent study, 79% of cats (15/19 cats) with presumed spinal cord infarction have favorable outcomes and these results suggest that the prognosis for cats receiving adequate supportive care is good (17).

Although the histological examination is needed for the definitive diagnosis, antemortem diagnosis is based on clinical presentation, exclusion of other causes of acute spinal disorder and imaging features describing for spinal cord infarction on MRI.

The common MR features of acute spinal cord infarction are relatively focal sharp demarcated intramedullary hyperintense lesions on T2 weighted and FLAIR images predominantly involving grey matter because of its greater metabolic demand with variable contrast enhancement (1,17). Contrast enhancement is indistinct within 5~7days after the onset of signs because revasculization of the lesion usually takes 5~7days (16). But it may be variable depending on the degree of occlusion to the blood supply to the nervous tissue and the rate of neovasculization (1).

The most important differential diagnosis of spinal cord infarction is acute non-compressive nucleus pulposus extrusion whose clinical signs are similar with spinal cord infarction (10). But this disease occur after traumatic events and MR findings are different with acute spinal cord infarction. MR findings of acute non-compressive nucleus pulposus extrusion include a focal intrameullary hyperintense lesion similar to acute spinal cord infarction (4). But this lesion overlies an intervertebral disc with reduced volume and materials or signal change in the epidural space dorsal to the affected disc. In these two cases, the absence of trauma history and MR features are compatible with acute spinal cord infarction rather than acute non-compressive nucleus pulposus extrusion.

In one recent study, the most common lesions based on MRI in cats were to the C1-C5 (30%) and C6-T2 (30%) spinal cord segments, with the T3-L3 and L4-S1 spinal cord segments accounting for 25% and 15%, respectively (17). If MRI is performed within 1~2 days after the onset of signs, the MR imaging may be normal because the ischemic insults, the size of infarction, the availability of high contrast resolution MRI affect the ability of the detection signal change (11). So, in human cases, repeated MRI has been emphasized for the detection of acute spinal cord infarction (2).

And DWI has been adopted for the detection of acute spinal cord infarction in humans (3,8,9,18). DWI detects of water molecule random motion and ADC is quantitative expression of water motion using DWI. On acute infarction, cytotoxic edema occur with reduction of ECF (extracellular fluid) and increased cell swelling and diffusion of free water molecule is reduced with increased restriction. As a result, high signals on DWI and low signals on ADC are appeared by these pathologic changes (15). So DWI has been widely used for the detection of brain infarction and there are numerous reports about the high sensitivity and usefulness of DWI in brain infarction (12,14,15). In contrast, the application of DWI in spinal cord has been limited for the small size of the spinal cord itself, low spatial resolution, involuntary motion and the magnetic susceptibility to artifacts caused by vascular and CSF pulsation (8,18). However, to overcome these limitations and to visualize the optimal imaging of spinal cord using DWI, several efforts such as new radiofrequency coil technology, software innovation are being made (18). The recent studies about DWI in spinal cord infarction have been published (2,7,8). In one clinical study, DWI was performed 30hrs after the onset of signs and the images showed increased signals on DWI and decreased signals on ADC and our two cases show very similar signal changes on DWI and ADC (7). In this study, 11days later ADC was increased suggesting pseudonormalization. These time course imaging features are consistant with brain infarction (12). Although the exact sensitivity and specificity of DWI for the diagnosis of spinal cord infarction in small animals could not be identified, these two cases show that DWI could be a potential useful tool in the early detection of spinal cord infarction in veterinary medicine.

Although a definitve diagnosis can only be made based on postmortem histopathological examination of the spinal cord, the MR findings in both cases were highly suggestive of acute spinal cord infarctions in cats based upon previous reported small animal cases and human cases.

In conclusion, conventional MR imaging features based on typical sequential appearance, together with the signalment, history, clinical signs and exclusion of other causes in acute myelopathy through clinical examination, can suggest of spinal cord infarction. And recently the diagnosis of spinal cord infarction can be obtained successfully by using advanced MR imaging such as DW MRI and ADC map which appear specific intensity in acute infarction. In conclusion, MRI can be a useful diagnostic tool for the acute spinal cord infarction in cats.

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두 마리 고양이에서 발생한 급성 척수 경색의 자기 공명 영상학적 진단 증례

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요 약 : 척수 경색은 고양이에서 급성 척수 병증의 주요한 원인으로써 인식되고 있다. 사후 조직 병리학적 검사를 통해 확진 할 수 있지만 MR 영상학적 특징은 척수 경색의 진단에 가치있는 정보를 제공한다. 본 증례의 목적은 두 마리의 고양이에서 발생한 급성 척수 경색의 영상학적 특징을 설명하고 그 진단에 있어서 low field MRI (0.3 Tesla)의 유용성을 평가하는 것이다. 미확인 연령의 중성화 수컷, mixed breed 고양이가 급성의 사지 부전 마비를 주증으로 내원하였고 9살령의 중성화 암컷 domestic short hair 고양이는 후지 부전 마비로 내원하였으며 하루 후 후지 완전 마비가 나타났다. 이후 실시된 MR 영상에서 첫번째 고양이의 경우 두번째 경추부터 여섯번 째 경추 수준의 척수에서 병변이 분포하였으며 두번째 고양이의 경우 두번째 요추부터 다섯번째 요추 수준에서 병변이 나타났다. 두 고양이에서 공통적으로 주로 회백질에 분포한 척수 실질 내에 국소적인 병변이 확인되었으며 T2 강조 영상 및 FLAIR 영상에서 고신호를 나타내었고 DWI 영상에서 고신호, ADC map 에서는 저신호를 나타내었다. 히스토리, 임상증상 및 다른 실험실적 검사와 함께 MR 영상학적 특징을 통해 두 고양이에서 급성 척수 경색이 진단되었다.

주요어 : 급성 척수 경색, 고양이, MR 특징, 진단