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**Spontaneous conus infarction with "snake-eye appearance" on magnetic resonance imaging: A case report and literature review**

Qiao-Yu Zhang, Lin-Ying Xu, Ming-Li Wang, Hua Cao, Xiao-Fei Ji

**Abstract**

**BACKGROUND**

Infarction of the conus medullaris is a rare form of spinal cord infarction. The first symptom is usually acute non-characteristic lumbar pain, followed by lower limb pain, saddle numbness, fecal incontinence, and sexual dysfunction. Spontaneous conus infarction with "snake-eye appearance" on magnetic resonance imaging has rarely been reported.

**CASE SUMMARY**

We report a 79-year-old male patient with spontaneous conus infarction who had acute lower extremity pain and dysuria as the first symptoms. He did not have any recent history of aortic surgery and trauma. Magnetic resonance imaging revealed a rare "snake-eye appearance." In addition, we reviewed the literature on 23 similar cases and summarized the clinical features and magnetic resonance manifestations of common diseases related to the "snake-eye sign" to explore the etiology, imaging findings, and prognosis of spontaneous conus infarction.

**CONCLUSION**

We conclude that acute onset of conus medullaris syndrome combined with "snake-eye appearance" should be strongly suspected as conus medullaris infarction caused by

anterior spinal artery ischemia. This special imaging manifestation is helpful in the early diagnosis and treatment of conus infarction.

## **INTRODUCTION**

Spinal cord infarctions account for approximately 1.2% of all ischemic strokes<sup>[1]</sup>, and less than 10% of acute non-traumatic myelopathies<sup>[2]</sup>. The most common infarct sites are the cervical and thoracic segments<sup>[3]</sup>. The common clinical manifestations of spinal cord infarction are motor and sensory disorders with impaired autonomic nerve function, and the specific manifestations are related to the affected sites<sup>[4]</sup>. Combined with the observation of the clinical manifestations, magnetic resonance imaging (MRI) and cerebrospinal fluid examination are helpful in distinguishing this condition from optic neuromyelitis pedigree diseases, acute disseminated encephalomyelitis, spinal cord tumors, multiple sclerosis, intervertebral disc herniation, and other spinal cord diseases. However, the lack of specific MRI features in conus medullaris infarction increases the difficulty of early diagnosis and recognition. In this paper, we report a case of spontaneous conus medullaris infarction. Simultaneously providing an analysis of the literature, we focus on the special imaging manifestations and etiological mechanisms of this condition <sup>1</sup> to improve clinicians' understanding of this disease.

## **CASE PRESENTATION**

### ***Chief complaints***

A 71-year-old Chinese man with a complaint of sudden onset of pain in both lower extremities and urination disorders for 2 d.

### ***History of present illness***

The patient experienced continuous pain on the back of both lower limbs when standing up from the sofa before 2 d, accompanied by muscle spasm, increased pain while sitting, urinary incontinence, and difficulty defecating, but no erectile dysfunction.

2

### *History of past illness*

The patient had a history of hypertension for 5 years and diabetes for 2 years. In the last year, the patient regular oral administration of Amlodipine besylate tablets was 5 mg qd, and the blood pressure was stable at 17-20/9-11kPa; Metformin 0.5 g tid and the glycosylated hemoglobin was 6.8%.

### *Personal and family history*

The patient has been smoking for 43 years, about 10 cigarettes a day. The patient denies any family history of disease.

### *Physical examination*

After 48 h of onset, neurological examination showed normal muscle strength and muscle tension in both lower limbs. The bilateral knee reflex was symmetrical, with no hyperactivity and weakness, the bilateral Achilles tendon reflex disappeared, the saddle area sense was normal, anal reflex was weakened, the urinary retention was moderate, and lack of the bilateral Babinski sign.

### *Laboratory examinations*

No obvious abnormalities were found in the test results of perfect nail work, serum immunology, tumor markers, or coagulation images.

### *Imaging examinations*

On the 4<sup>th</sup> day of onset, lumbar MRI revealed a high signal on the L1 horizontal axial T2-weighted image with a "snake-eye appearance", and conus infarction was thus considered. On the 5<sup>th</sup> day of onset, lumbar MRI showed a high signal on L1 horizontal sagittal diffusion-weighted imaging (DWI) (Figure 1).

### **FURTHER DIAGNOSTIC WORK-UP:**

Spinal angiography and aortic angiography (CTA) improved, but no definite vascular stenosis or malformation was identified. On the 7<sup>th</sup> day of onset, the measurement of nerve conduction velocity revealed that the F-wave latency of the left tibial nerve was prolonged.

### **LITERATURE REVIEW**

We used the key terms "conus medullaris infarction," "conus medullaris syndrome," "spinal cord ischemia," "spinal cord infarction," "snake-eye appearance" and "owl-eye appearance" to search the literature on PubMed. We thus identified and summarized 23 cases of conus medullaris infarction from January 1971 to January 2021 (Table 1)<sup>[5-21]</sup>.  
3 The male to female ratio was 1.3:1. The median age at onset was 63 years. Eleven cases (47.8%) were complicated by cardiovascular risk factors, 7 (30.4%) were related to aortic disease, and 3 (13.0%) were secondary to postural changes, similar to the present case. Other causes included dural arteriovenous fistulas, spinal cord venous thrombosis, fibrocartilage embolism, and so on; 9 cases (39.1%) showed a high signal on axial T2-weighted imaging, of which 2 cases showed the typical "snake-eye appearance" high signal on sagittal T2-weighted imaging in the T10 to L1 vertebral segments, 3 cases (13.0%) showed limited DWI, 5 cases (21.7%) involved the vertebral body/muscle/ligament at the same time, and 16 cases (69.6%) showed a partial recovery of neurological deficit, with sequelae of varying degrees, while 5 cases (21.7%) had no improvement, and the overall prognosis was poor.

### **FINAL DIAGNOSIS**

Combined with the patient's medical history, spontaneous spinal cord infarction was confirmed.

### **TREATMENT**

The patient was admitted to the hospital and administered clopidogrel to facilitate antiplatelet aggregation and atorvastatin calcium tablets to reduce blood lipid levels.

### **OUTCOME AND FOLLOW-UP**

After 10 d of treatment, the pain in both lower extremities was relieved, and the symptoms of urinary retention were relieved. After discharge, the patient continued to take clopidogrel and atorvastatin calcium tablets orally. After 3 mo of telephone follow-up, the patient complained of left lower limb pain and prolonged urination time.

### **DISCUSSION**

Conus medullaris infarction is rare, and its incidence is unclear. A study on the clinical and magnetic resonance imaging manifestations and short-term prognosis of patients with spinal cord infarction showed that only 12.5% had isolated conus medullaris infarction<sup>[22]</sup>. The blood supply to the conus medullaris is very rich and mainly supplied by the anterior spinal artery, posterior spinal artery, and nerve root medullary artery. The anterior spinal artery supplies the first two-thirds of the conus medullaris, and the posterior spinal artery supplies the last one-third. These form a coronary artery ring at the level of the conus medullaris, which then branches from the artery ring into the conus medullaris. In addition, the thick nerve root medullary artery (Adamkiewicz artery) from the intercostal or lumbar artery from T9 to T12 and the desproges gotteron artery originating from the iliolumbar artery are also involved in the blood supply to the spinal conus<sup>[6,23-25]</sup>. At present, the diagnosis of conus medullaris infarction is mainly based on clinical manifestations and MRI findings. Lumbar puncture cerebrospinal fluid examination is helpful in distinguishing between inflammatory and demyelinating diseases. In January 2019, Zalewski *et al*<sup>[26]</sup> proposed the diagnostic criteria for spontaneous spinal cord infarction, emphasizing that the high signal on a MRI intramedullary T2-weighted image is evidence of acute spinal cord infarction, while the DWI/apparent diffusion coefficient diffusion is limited, accompanied by corresponding pyramidal infarction, arterial dissection, or occlusion near the lesion. However, it is important to note that T2-weighted magnetic resonance imaging has a low sensitivity.

In a clinical study<sup>[27]</sup>, only 45% of patients with acute spinal cord infarction showed a high signal on T2-weighted magnetic resonance imaging. The volume of the conus medullaris is smaller, the magnetic sensitivity artifact tendency of DWI is higher, and the detection sensitivity is much lower than those of acute cerebral infarction. Therefore, early neurological function evaluation is very important in identifying patients with negative MRI findings. The MRI results of this patient were consistent with the above standards. It is worth noting that the patient had an isolated "snake-eye appearance" high signal on axial T2-weighted MRI at the level of the spinal cord cone. This "snake-eye appearance" was first described in the results of delayed myelography in 7 patients with compressive cervical spondylotic myelopathy in 1986<sup>[28]</sup>, and is also known as "owl-eye appearance". The main pathological changes which can result in this appearance are cystic necrosis of the central gray matter of the ventrolateral column of the spinal cord and loss of neurons in the anterior horn of the spinal cord<sup>[29]</sup>. It is usually related to lower motor neuron syndrome, such as Hirayama disease<sup>[30,31]</sup>, spinal muscular atrophy syndrome<sup>[32]</sup>, cervical spondylotic myelopathy<sup>[33]</sup>, amyotrophic lateral sclerosis<sup>[34]</sup>, and anterior spinal artery ischemia<sup>[35-37]</sup>. Detailed identification is shown in Table 2<sup>[34,38-41]</sup>. There is a watershed area between the sulcus commissural artery and the coronary artery ring sent by the anterior spinal artery. The anterior horn cells of the spinal gray matter in this area are highly sensitive to hypoxia; when local or overall perfusion is insufficient, they are prone to degeneration and necrosis, forming a "snake-eye appearance" high signal limited to the anterior horn of spinal gray matter on the T2-weighted image of the magnetic resonance imaging axis<sup>[42,43]</sup>. When this "snake-eye appearance" appears during acute onset myelopathy, a vascular origin should be highly suspected. The most commonly used method is aortic CTA. Thoracic and abdominal CTA can help detect aortic atherosclerotic plaques, dissection, aneurysm, and mural thrombosis. If the CTA result is negative, spinal angiography is necessary to exclude dural arteriovenous fistula and spinal intramedullary arteriovenous malformation<sup>[4]</sup>. Wildgrube *et al*<sup>[13]</sup> previously reported a case of conus medullaris infarction with "snake-eye appearance", caused by spinal cord venous thrombosis. Thus, it is necessary

to evaluate thrombophilic factors and improve spinal cord angiography to distinguish between venous and arterial conus medullaris infarction. The cell number and IgG index of cerebrospinal fluid in patients with spinal conus infarction are usually normal. There is no oligoclonal band, and the protein content in cerebrospinal fluid can be slightly increased in some patients<sup>[6-7,20,26]</sup>. A previous study<sup>[44]</sup> proposed two mechanisms of spinal cord infarction: (1) Infarction triggered by mechanical factors (bilateral anterior or posterior spinal cord artery infarction and unilateral infarction) and (2) infarction caused by long-term hypotension or arterial insufficiency (central spinal cord artery infarction and transverse spinal cord infarction). In this case, the patient was associated with cardiovascular risk factors, such as hypertension, diabetes, and smoking, but had no definite history of trauma before disease onset. However, upon presentation, he complained of suffering from bilateral lower extremity pain after completing mechanical action from the sofa, and urination disorder was observed. We speculated that the possible mechanism was based on atherosclerosis in the anterior spinal cord. Mechanical stress can lead to anterior spinal artery ischemia. At present, the treatment principles for spinal cord infarction mainly refer to the guidelines for acute ischemic stroke. Old age, severe initial neurological deficit, and long segment lesions are considered to be related to poor prognosis<sup>[22,27,45,46]</sup>. The prognostic value of the "snake-eye appearance" on magnetic resonance imaging in acute myelopathy is unclear, but may be related to the poor prognosis of chronic myelopathy<sup>[29,47,48]</sup>.

Conus medullaris infarction is rare in the clinic and has a high misdiagnosis rate. Detailed medical history and physical examination were the basis of the diagnosis. Although the "snake-eye appearance" is not specific to spinal cord MRI, acute low back pain or bilateral lower limb pain is usually the first symptom, and its clinical manifestation is conus syndrome or cauda equina syndrome. When the axial T2-weighted image of MRI shows "snake-eye appearance", it is necessary to differentiate between spinal conus infarction caused by anterior spinal artery ischemia. Improving aortography, spinal angiography, and cerebrospinal fluid examination will help to clarify the etiology.



The limitations of this report are its short follow-up period and lack of imaging and neurophysiological evaluation results during the follow-up period. Although we have reviewed previously reported cases of conus medullaris infarction, authors may have different descriptions of clinical characteristics and results. More cases need to be analyzed in the future to improve clinicians' understanding of this disease.

### **CONCLUSION**

We conclude that acute onset of conus medullaris syndrome combined with "snake-eye appearance" should be strongly suspected as conus medullaris infarction caused by anterior spinal artery ischemia. This special imaging manifestation is helpful in the early diagnosis and treatment of conus infarction.

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2%

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