

## Imaging Diagnosis of Sacrocaudal Dysgenesis in a Shih-tzu Dog

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**Abstract :** A 10-month-old, intact female Shih-tzu dog with a pelvic limb ataxic gait, and urinary and fecal incontinence since birth, was examined by computed tomography and magnetic resonance imaging. The butterfly hemivertebra of the fourth lumbar vertebra, agenesis of the third sacral and coccygeal vertebrae, and spina bifida of the remaining sacral vertebra were observed on the computed tomography images. Magnetic resonance imaging revealed traction of the conus medullaris. The dog was diagnosed with sacrocaudal dysgenesis with presumptive tethered cord syndrome, and concurrent infectious cystitis was found by ultrasonography and urinary analysis. The Shih-tzu recovered from the cystitis, but still has the ataxic gait and urinary and fecal incontinence. This report summarizes the case of a dog with sacrocaudal dysgenesis that was identified by imaging diagnosis.

**Key words :** CT, cystitis, dog, MRI, sacrocaudal dysgenesis.

### Introduction

Sacrocaudal dysgenesis covers a spectrum of congenital abnormalities involving both the bony and soft tissue structures of the lumbosacral and coccygeal spine, and results in neurological deficits such as hindlimb paresis and urinary and fecal incontinence (4). It occurs most commonly in Manx cats with a particular inheritable autosomal dominant trait that provides the genetic basis for taillessness (10). The exact etiology is poorly understood and has been described very rarely in other cat breeds, Swiss mice, and a calf (6,7,9).

This case report described a shih-tzu dog with sacrocaudal dysgenesis diagnosed by radiography, computed tomography (CT) and magnetic resonance imaging (MRI).

### Case

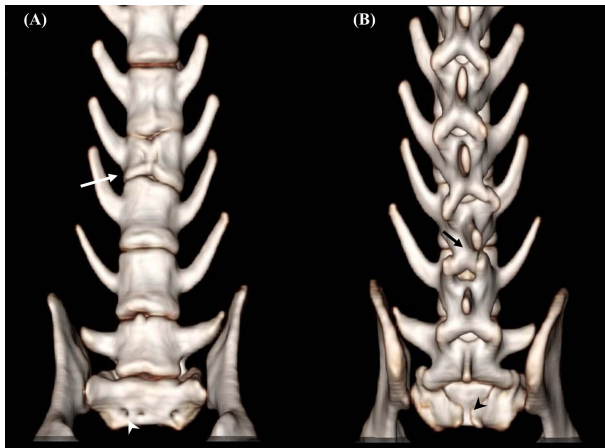
A 10-month-old, intact female Shih-tzu dog was referred for the investigation of a pelvic limb ataxic gait, and urinary and fecal incontinence that were consistently present since birth. Physical and neurological examinations, radiography, CT, and MRI were performed to evaluate a possible neurological dysfunction.

The physical and neurological examinations revealed the absent tail, decreased proprioceptive response of the hindlimbs, and decreased perineal reflex. The radiography showed a butterfly hemivertebra of the fourth lumbar vertebra (LV) with no coccygeal vertebra and a loss of the caudal part of the

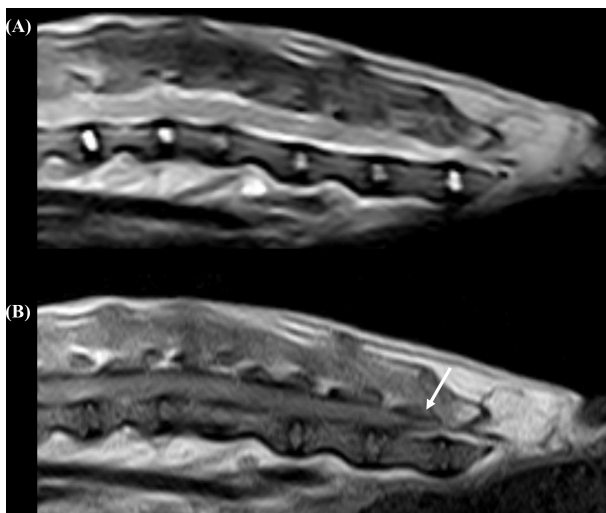
sacrum. On pre-anesthetic evaluation for CT and MRI, there were leukocytosis (38.8 K/ $\mu$ L; reference 6.0 K/ $\mu$ L to 12.0 K/ $\mu$ L), anemia (2.89 M/ $\mu$ L; reference 5.5 M/ $\mu$ L to 8.5 M/ $\mu$ L), and decreased hematocrit (20.5%; reference 35% to 55%) in complete blood cell counts and serum chemistry, and irregular thickening of the urinary bladder wall in abdominal ultrasonography. Marked proteinuria and microscopically rod-shaped bacteria were found in urinary analysis, and *Yersinia* spp. was identified in urine culture.

For CT (Asteion 4<sup>®</sup>, Toshiba, Tokyo, Japan) and MRI (Vet-MR<sup>®</sup>, Esaote, Genoa, Italy) scanning, general anesthesia was induced with propofol (4 mg/kg to 6 mg/kg, intravenously), and maintained with isoflurane and oxygen after premedication with butorphanol (0.2 mg/kg, intravenously) and midazolam (0.2 mg/kg, intravenously). For precontrast CT scanning, the dog was positioned in sternal recumbency with the hindlimbs extended. The CT images showed agenesis of the partial sacral and entire coccygeal vertebrae, along with only a pair of pelvic sacral foramina on the remaining sacral vertebra and spina bifida of the incomplete dorsal laminae. Partial unilateral failure of vertebral body formation on either side of the butterfly hemivertebra, and misalignment of the spinous process and caudal articular process of the fifth LV were seen (Fig 1). MRI scanning was performed with the imaging protocol involving sagittal (TR/TE/NEX, 3267/90/2) and transverse (2800/90/2) plane T2-weighted, and sagittal (600/26/2) and transverse (633/26/2) plane T1-weighted sequences on the right lateral recumbency, with an extended hindlimb position. On MRI, the conus medullaris of the spinal cord extended until the caudal aspect of the seventh LV, and the caudal equina was finished abnormally by fatty tissue at the caudal aspect of the incomplete sacrum (Fig 2). The T2 sig-

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**Fig 1.** Ventral (A) and dorsal (B) aspects of volume-rendering computed tomography images of a Shih-tzu dog with sacrocaudal dysgenesis. Several vertebral anomalies, such as butterfly hemivertebra of the fourth lumbar vertebra (white arrow), partial loss of the sacral vertebra, and complete loss of the coccygeal vertebra, were observed on the ventral aspect, and only a pair of pelvic sacral foramina (white arrowhead) appeared. Spina bifida of the remaining sacral vertebra (black arrowhead) and misalignment between the spinous process and the caudal articular process (black arrow) were observed on the dorsal aspect.



**Fig 2.** Mid-sagittal T2-weighted (A) and T1-weighted (B) magnetic resonance images. The conus medullaris of the spinal cord extended until the caudal aspect of the seventh lumbar vertebra on both A and B (arrow), and no another spinal cord lesion associated with the clinical signs was observed.

nal of the intervertebral disc between the fourth and fifth LV was decreased, and no additional abnormality for myelopathy was found in the thoracolumbosacral region. Consequently, a diagnosis of sacrocaudal dysgenesis with concurrent infectious cystitis and tethered cord syndrome was suspected. The dog's owner decided not to proceed with surgical intervention. On a follow-up examination three months later, the dog had recovered from the cystitis, but the ataxic gait, and urinary and fecal incontinence remained.

## Discussion

Sacrocaudal dysgenesis has been comprised in caudal regression syndrome, which is partial or complete congenital malformation characterized by developmental failure involving the legs, and the lumbar, sacral, and coccygeal vertebrae in human medicine (16). Sacrocaudal dysgenesis is often accompanied by the other bony anomaly spina bifida and the soft tissue anomaly meningocele in Manx cats and humans (4,5,8). In the dog described in the present case report, sacrocaudal dysgenesis was identified with spina bifida, but without meningocele.

Sacrocaudal dysgenesis results in hindlimb paresis and urinary and fecal incontinence, and progressive clinical signs are caused by vertebral segment instability or tethered cord syndrome (2,4,15). Detailed neuroimaging investigations, like CT and MRI, are required for the optimal diagnosis and surgical intervention of variable congenital anomalies such as meningocele, spinal dysraphism, and dermoid sinus (3,11,13,14).

Tethered cord syndrome represents a disorder with caudal traction of the conus medullaris due to abnormal fixation of the filum terminale (12), and sacrocaudal dysgenesis in Manx cats has been associated with tethered cord syndrome (2,4). Neurological dysfunctions of the lumbosacral spinal segment such as hyperesthesia, proprioceptive deficit, decreased spinal reflexes of the hindlimbs, and urinary and fecal dysfunction are caused by tethered cord syndrome (4), and the clinical signs could advance by progressive and repeated traction (3,12). The clinical signs could be recovered completely by surgical untethering (3). MRI is useful for diagnosing tethered cord syndrome in humans, but an imaging diagnosis for dogs is not specific because of the variability for termination of the conus medullaris (3). In a report of an English Cocker Spaniel with tethered cord syndrome, termination of the conus medullaris until the cranial aspect of the seventh LV was observed as a possible caudal deviation on MRI (3). In the present case, based on the caudal termination of the conus medullaris seen on MRI, tethered cord syndrome was suspected in this Shih-tzu. However, surgery or histopathological observation was not performed, and the abnormal fixation of the filum terminale was not confirmed.

Bacterial urinary tract infection has been reported in patients with thoracolumbar intervertebral disc extrusion (17), and may predominate in one or more urinary system (1). Urinary incontinence increases the likelihood of a urinary tract infection (17). Bacterial cystitis should be considered as a disease concurrent with sacrocaudal dysgenesis in dogs.

Sacrocaudal dysgenesis is common in Manx cats, and is a rare vertebral anomaly that can also be observed in dogs. The present report showed the sacrocaudal dysgenesis concurrent with cystitis and tethered cord syndrome diagnosed by radiography, CT, and MRI in a Shih-tzu dog.

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