Tethered Cord Syndrome Associated with a Thickened Filum Terminale in a Dog

S. De Decker, T. Gregori, P.J. Kenny, C. Hoy, K. Erles, and H.A. Volk

Key words: Cauda equina; Lumbosacral; Spinal dysraphism; Spinal malformation.

A 1-year-old female neutered English Cocker Spaniel was presented with a 9 months history of progressive right pelvic limb lameness. Survey radiographs, computed tomography (CT), magnetic resonance imaging (MRI), and joint taps of the pelvis, stifles, hock joints and tarsi, performed before referral, were within normal limits. Medical management with meloxicam did not result in clinical improvement. Treatment with gabapentin, initiated 7 days before presentation, resulted in improvement. General physical examination did not reveal any abnormalities. Neurological examination revealed paraparesis, right pelvic limb lameness, a low tail carriage, proprioceptive deficits expressed by delayed hopping, but intact paw placement in both pelvic limbs, a reduced withdrawal reflex in the right pelvic limb and decreased tail tone. Pain was elicited on lumbosacral palpation, dorsal extension of the tail and extension of both hips. The remainder of the neurological examination was within normal limits. Her neurological lesion was localized to the L4-S3 spinal cord segments. A complete blood count and biochemistry panel were within normal limits. After premedication with methadone (0.2 mg/kg IM) and acepromazine (0.01 mg/kg IM), anesthesia was induced with propofol (4-6 mg/kg, IV), and maintained with sevoflurane in oxygen. MRI of the lumbar and lumbosacral vertebral column was performed with the dog in dorsal recumbency with flexed limbs (ie, frog-leg position). The imaging protocol included sagittal and transverse plane T2-weighted (repetition time (ms) (TR), echo time (ms) (TE), 3000/120) sequences. Sagittal and transverse plane T2-weighted BAL (TR, 7.9/3.9) sequences. Sagittal and transverse plane T1-weighted (T1W TSE) (TR/TE, 400/8) images were acquired before and after IV injection with gadolinium contrast. MRI demonstrated possible caudodorsal displacement of the conus medullaris. Mild lumbosacral intervertebral disk protrusion was also seen (Fig 1). After MRI, a CT examination of the lumbosacral vertebral column was performed using a 16-slice scanner. After completion of the transverse CT study, sagittal and dorsal reconstructions were made. CT imaging (Fig 2) confirmed the MRI findings and did not reveal any other vertebral or spinal abnormalities. Differential diagnoses included tethered cord syndrome and dynamic lumbosacral vertebral canal stenosis. Given her initial positive response, medical management was continued with gabapentin (10 mg/kg, q8h, PO), carprofen (2mg/kg, q12h, PO) and restricted exercise for 4 weeks. A re-examination 4 weeks later demonstrated progression of her clinical signs characterized by more pronounced paraparesis and right pelvic limb lameness. General anesthesia was induced and maintained with the aforementioned protocol. A standard dorsal lumbosacral laminectomy, from L7 to S2, was performed. After opening the vertebral canal, a ligamentous structure was identified between the conus medullaris and the dorsal lamina of S2, which caused caudodorsal displacement and traction of the conus medullaris (Fig 3A,B). After sectioning and sampling the distal aspect of this ligamentous structure, the conus medullaris regained a more cranial position. The wound was closed routinely. Intraoperative analgesia was provided with ketamine (loading dose of 0.5 mg/kg IV followed by a CRI at 10 μg/kg/min IV) and methadone (0.1 mg/kg q4h, IV). Postoperative analgesia consisted of a combination of methadone (0.2 mg/kg, q4h, IV), carprofen (2 mg/kg, q12h, PO) and gabapentin (10 mg/kg, q8h, PO). The dog was discharged from hospitalization 4 days after surgery. The owner was advised to provide strict rest for 4 weeks in combination with gabapentin and carprofen for 2 more weeks.
Histopathological evaluation revealed a combination of elastin and collagen fibers in parallel arrangement, confirming the ligamentous nature of the sampled tissue (Fig 3C). The surgical- and histopathological findings were considered diagnostic for tethered cord syndrome associated with a thickened and shortened filum terminale. A neurological examination 4 weeks after surgery revealed marked clinical improvement. At this time, the dog demonstrated mild lameness and proprioceptive deficits in the right pelvic limb. A neurological examination 10 weeks after surgery did not reveal any abnormalities. A telephone interview with the owner and referring
veterinary surgeon 8 months after surgery revealed that the dog was free of clinical signs.

Tethered cord syndrome (TCS) represents a spectrum of congenital anomalies characterized by an abnormal caudal position and traction of the conus medullaris.\(^1\),\(^2\) It can be associated with a variety of spinal malformations, including fatty infiltration of the filum terminale and open and closed forms of spinal dysraphism.\(^3\) TCS can, however, also be associated with an abnormally thickened, inelastic, and shortened filum terminale without other spinal or vertebral malformations.\(^3\) In people, this is also referred to as true or primary TCS.\(^1\),\(^4\) In the case presented here, no other spinal or vertebral malformations were present and caudal traction of the conus medullaris was most likely caused by an abnormally thickened, inelastic, and shortened filum terminale. Although reported in conjunction with an intradural lipoma, myelomeningocele, spina bifida, myeloschisis, and a split cord malformation\(^5\)–\(^9\), this case report, to the best of the authors’ knowledge, represents the first veterinary report of TCS associated with a thickened filum terminale.

---

**Fig 3.** (A, B) Intraoperative pictures demonstrating caudal traction of the conus medullaris associated with a thickened filum terminale (arrow). Other intraoperative abnormalities included moderate hypertrophy of the ligamentum flavum (asterisk). (C) Histopathological evaluation (HE staining) demonstrated a combination of elastin and collagen fibers in parallel arrangement. × 40 Bar: 0.5 mm.
termine. The conus medullaris is the tapered ending of the spinal cord and is continued by a filament, the filum terminale. The filum terminale extends caudally and attaches to a sacral or caudal vertebra. Thinning of the filum terminale and subsequent TCS results from abnormal embryological development of the filum terminale during the process of retrogressive differentiation. The process of neurulation is not responsible for formation of the entire spinal cord. Distal to the conus medullaris and undifferentiated cells form the caudal cell mass. This structure will proliferate, canalize, fuse with the neural tube and will eventually develop into the conus medullaris, cauda equina, and filum terminale. The filum terminale forms through regression of the most caudal portion of the caudal cell mass during a process called retrogressive differentiation. A thickened filum terminale may result from incomplete involution of the caudal cell mass. The thickened and shortened filum terminale causes progressive and repeated traction on the conus medullaris and caudal spinal cord segments. This results in decreased blood flow and decreased oxidative metabolism of the spinal cord segments just cranial of the inelastic abnormality. TCS therefore typically results in progressive dysfunction of the lumbosacral spinal cord segments.

The degree and reversibility of this dysfunction depends on both the magnitude and duration of the excessive traction. In the case reported here, reaching a diagnosis of TCS proved to be very challenging. Interpretation of advanced imaging was subjective and unfortunately inconclusive. A diagnosis of TCS was only confirmed on both the magnitude and duration of the excessive traction.

In summary, this report described TCS associated with a thickened filum terminale in a dog. Reaching a diagnosis was challenging and surgery resulted in complete clinical recovery. TCS associated with a thickened filum terminale could be considered a rare differential diagnosis for lumbosacral neurological dysfunction in a young dog.

Funding: No funding was received for this study.
Conflict of Interest Declaration: Authors disclose no conflict of interest.
Off-label Antimicrobial Declaration: Authors declare no off-label use of antimicrobials.

References