

Cervical disc herniation in an adult captive Marsican brown bear (*Ursus arctos marsicanus*): diagnosis and surgical therapy



The Marsican bear (*Ursus arctos marsicanus*), or Apennine bear, is a subspecies of the European brown bear which is exclusively endemic to central Italy. The present work describes a case of cervical disc herniation in a captive bear housed in the wildlife area of the Parco Nazionale d'Abruzzo, Lazio e Molise, examined following the sub-acute onset of ambulatory tetraparesis not responsive to anti-inflammatory treatment. A spinal CT scan revealed the presence of voluminous hyperdense material lying on the floor of the vertebral canal at the level of the C5-C6 intervertebral space, consistent mainly with disc herniation. In view of the failure of the medical treatment a ventral slot surgical approach was performed; the spinal cord was decompressed and a gradual complete recovery was achieved. The present report shows that the above mentioned technique can be performed successfully in bears. This, to the author's knowledge, is the first report describing a cervical disc herniation in the bear and the first describing a consequent ventral slot decompression surgery.

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INTRODUCTION

Disc extrusion, or Hansen type 1 disc herniation, is a common neurological condition in the dog; it causes varying clinical signs depending on the onset, location and amount of herniated material.¹ In the dog, it is more frequently found in the thoracolumbar and to a lesser extent in the cervical segments.¹

In the bear, only three cases of thoracic and lumbar disc extrusion have been described, only one of which underwent surgery.^{2,3,4}

This paper describes the clinical signs, radiographic findings and the outcome of a ventral slot decompression surgery of a herniated cervical disc in a Marsican brown

bear. To the knowledge of the authors, this is the only described case of tetraparesis and consequent surgical treatment in a bear.

DESCRIPTION OF THE CLINICAL CASE

A 25-year-old, intact, female Marsican brown bear (*Ursus arctos marsicanus*), weighing 131 kg, housed at the Visitor Centre of the Parco Nazionale d'Abruzzo, Lazio e Molise in Pescasseroli, Italy, was examined due to the sub-acute onset of ambulatory tetraparesis, present since about three months. The subject had been treated with various NSAIDs (meloxicam, 0.57 mg/kg sid; mavacoxib, 2 mg/kg sid) and corticosteroid (dexamethasone, 0.15 mg/kg sid) cycles, without any significant improvement. The neurological evaluation, carried out by examining video recordings, showed a vig-

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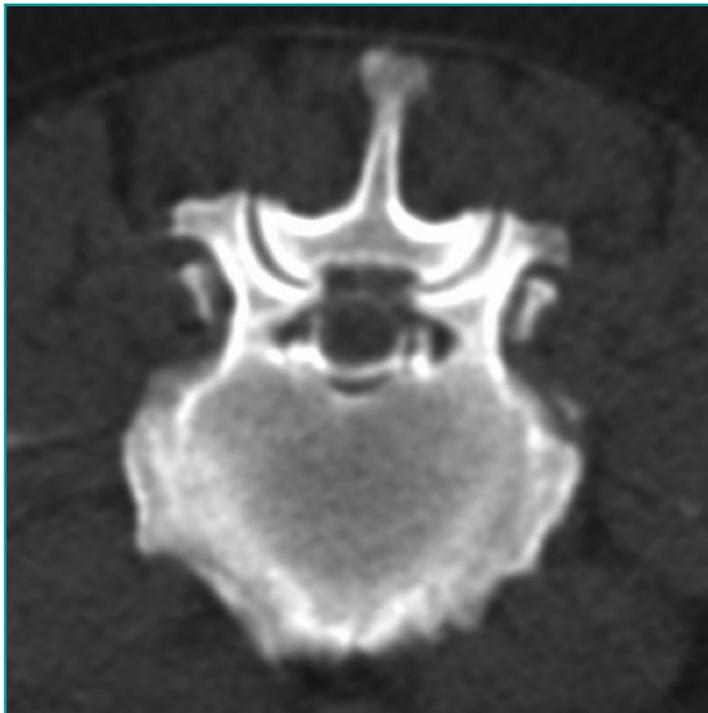


Figure 1 - Transverse myelo-CT scan at the intervertebral space L4-L5; extensive spondylosis present throughout the spine.

ilant and responsive mental status, reluctance to movement, difficulty in adopting the quadrupedal stance, gait with rigidity of the four limbs, hypometria of the fore-

Disc herniation is a common diagnosis in the dog; in the bear, only three cases are reported in the literature, at thoracic and lumbar level. Cervical disc herniation has never been previously described in the bear.

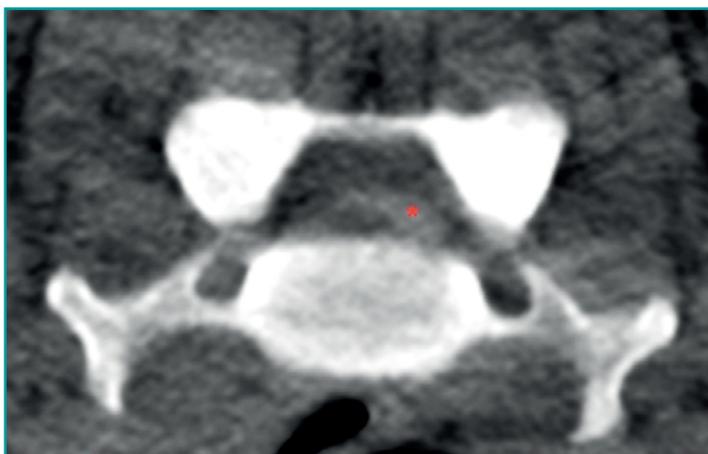


Figure 2 - Transverse CT scan immediately cranial to the intervertebral space C5-C6; disc extrusion (asterisk).

limbs, proprioceptive ataxia of the four limbs, tetraparesis more pronounced on the hind limbs and proprioceptive deficits of the hind limbs, especially to the right (video_01). The clinical signs were consistent with a cervico-thoracic segment (C6-T2) lesion of the spinal cord. The patient, sedated through darting with detomidine hydrochloride (0.12 mg/kg) and ketamine hydrochloride (2.24 mg/kg) was transported to the reference facility. The anaesthesia was deepened with the addition of detomidine and ketamine, at the same dosage used for sedation; a venous catheter was placed in the cephalic vein, propofol (2 mg/kg) was administered and the patient was then intubated; the anaesthesia was maintained with 1-1.5% isoflurane.

A single slice spiral computed tomography (CT) (Hitachi Pronto SE) was then performed before and after the subarachnoid administration of iodinated contrast medium (iopromide, 45 mg/kg). The complete scan of the spine showed the presence of 7 cervical, 14 thoracic and 6 lumbar vertebrae, extensive spondylosis (Fig. 1) and the presence of extradural material, hyperdense compared to the spinal cord, at the C5-C6 intervertebral space, consistent with disc material, with right median-paramedian spinal cord compression, (Fig. 2). A spinal tap and a myelo-CT were performed using a 20 gauge, 15.24 cm spinal needle inserted into the L5-L6 intervertebral space; no other clinically relevant lesions were found.

The CSF analysis presented 2 leukocytes per microliter (95% erythrocytes, 4% monocytes and 1% small lymphocytes), a 32.5 mg/dl protein content and Pandy's test was negative. Once the diagnostic procedures were completed, the patient was taken back to its housing.

The bear underwent additional anti-inflammatory therapy but because of the worsening of the clinical symptomatology a decompressive surgery was proposed. One month after performing the CT scan the bear was sedated using the same protocol described above and transported to the referral facility; after deepening the plane of anaesthesia, a ventral slot surgery was performed, as



Video 1
At the first evaluation the patient showed rigidity and hypometria of the forelimbs and ataxia and proprioceptive deficits of the hind limbs.
<https://www.scivac.it/it/v/20587/1>



Video 2
Postoperative gait (two days post-surgery).
<https://www.scivac.it/it/v/20587/2>

described in the dog (Figs. 3,4).⁵

During the entire surgical procedure no significant anatomical differences between the dog and bear were noted, except for the size; the same anatomical landmarks were used.

The post-operative CT scan performed at the level of the surgical site confirmed the complete removal of the compressing material; histopathology confirmed its discal origin.

After the procedure, the patient was transported to its housing; the post-operative therapy consisted of a single dose of a long-acting injectable antibiotic (cefovecin, 8 mg/kg) and anti-inflammatory corticosteroids *per os* (dexamethasone, 0.15 mg/kg sid), which were then gradually tapered in the ten days following surgery.

Two days after surgery the bear was able to maintain the quadrupedal stance and take short walks (video_02); within a week it was walking autonomously, although with some evident deficits (video_03); four months after surgery no proprioceptive deficits were present (video_04) and one year after surgery the bear was still neurologically normal.

DISCUSSION

The Marsican brown bear, or Apennine bear, is a subspecies of the European brown bear. It is endemic only to central Italy, in the Regions of Abruzzo, upper Lazio and Molise; the presence of erratic individuals is reported only sporadically in the most southern areas of the Regions Umbria and Marche.⁶ Its genetic and morphological characteristics differ from those of bears in the Alps and in the rest of Europe, due to the prolonged duration of its geographical isolation.^{6,7} The current population comprises about 50 individuals.⁸

In the literature, only a few cases of bear paraparesis have been reported^{2,4,9-15} and the subjects' mean age at presentation of the clinical signs was 22 years, with a high-



Figure 3 - Positioning of the patient for surgery: the bear is placed in dorsal recumbency, with spacers positioned between the table and the animal's neck in order to allow hyperextension; the forelimbs are extended caudally.

The Marsican brown bear is a species endemic to the central Apennines of Italy; their current number is estimated at around 50 individuals and they are genetically and morphologically different from Alpine and European brown bear populations.



Figure 4 -Ventral slot: the skin and the superficial fascia were dissected along the midline, from the wings of the atlas to about 10 cm cranial to the manubrium of the sternum. The sternocephalic and sternothyroid muscles were split along the midline, preserving the thyroid veins and cauterizing the side branches; the trachea, laryngeal nerve, carotid artery and vago-sympathetic nerve trunk were protected and retracted, in order to expose the longus colli muscle that was elevated from the underlying vertebral body; the structures were maintained in retraction using two Gelpi retractors. The correct site for the slot was identified by palpating the wings of the atlas and the transverse processes of C6. The fibrous annulus of the C5-C6 disc was incised with a scalpel blade number 11 and partially removed with bone forceps; a ventral slot was then performed using an air micro-motor with a 5 mm spherical bur and Kerrison bone rongeur. After dissecting

the longitudinal dorsal ligament, the material compressing the spinal cord was removed.



Video 3
Postoperative gait (one week post-surgery): the patient was able to walk autonomously, although with evident deficits.

<https://www.scivac.it/it/v/20587/3>



Video 4
Gait four months post-surgery.

<https://www.scivac.it/it/v/20587/4>

Table 1 - Spinal cord compression in the bear: characteristics, diagnosis and performed treatment.
Legend: NA not available; NE not executed; F female; IF intact female; M male; IM intact male; if an MRI examination was performed the Tesla of the machine used are indicated.

Publication	Species	Age (Years)	Weight (Kg)	Sex	Clinical signs	Imaging	Diagnosis	Therapy	Outcome	Other
Nichols 1980	American black bear	17	127	F	paraparesis	XR	T10-T11 disc extrusion	dorsal hemilaminectomy T10-T11	recovery in 1 year	
Klöpper 1991	Kodiak brown bear	40	NA	M	paraparesis	NE	C7-T1, T2-T3, T3-T4 exostosis		euthanasia	hepatic haemangioma
Wagner 2005	European brown bear	22	500	M	acute paraparesis progressed in paraplegia in one week	XR	L4-L5 disc extrusion, lumbar tract subdural haemorrhage, diffused spondylosis, multiple chronic disc spondylosis, T8-T9 disc extrusion, myelomalacia	NSAIDs	euthanasia	
Knafo 2012	American black bear	23	150	IF	progressive paraparesis (1 week)	XR e MRI (3T)			euthanasia	
Thomovsky 2012	American brown bear	15	250	IM	pain, intermittent right front limb lameness, ataxia, hind limbs proprioceptive deficits	MRI (1T)	vertebral stenosis with T1-T3 spinal cord dorsal compression, T3-T4 ganglion cyst	rest, NSAIDs, corticosteroids	euthanasia	normal EMG
	American brown bear	15	263	IM	paraplegia of unknown duration (onset during hibernation)	MRI (1T)	T2-T4 dorsal longitudinal ligament thickening, T3-T4 gliosis, T2-T3 and T3-T4 bulging	rest, NSAIDs, corticosteroids	euthanasia	CSF tap
Rosenzweig Büeler 2016	Syrian brown bear	19	250	IM	right hind limb lameness progressed in non ambulatory paraparesis in one week	XR, myelography	T2-T3 vertebral instability, dorsal longitudinal ligament thickening	T2-T3 dorsal laminectomy	functional recovery in 1 year	CSF tap
Morrison 2017	Polar bear	24	450	F	progressive paraparesis	XR, myelography	L5-L6 dorsal longitudinal ligament thickening	L3-S1 dorsal laminectomy	recovery in few weeks	
Current work	Marsican brown bear	25	135	IF	tetraparesis more severe on the right side, front limbs hypometria, ataxia, hind limbs proprioceptive deficits	XR, myelography	C5-C6 disc extrusion, spondylosis	C5-C6 ventral slot	total recovery at 4 months	CSF tap

er prevalence in male patients.^{2-4,9-15} In the wild, the average life expectancy of bears is of about 25 years, while in captivity these animals can be very long-lived: a report describes a case of paraparesis occurring in a 40-year-old subject.² It is possible that the alterations commonly described in older bears in captivity, such as dorsal longitudinal ligament hypertrophy, osteoarthritis and vertebral exostosis may not allow wild animals to live as long, hindering their motility.^{3,4,9,10} In addition, the higher prevalence in male subjects might be related to their greater weight or to gender-related behavioural differences which could predispose them to the above mentioned diseases, although the sample examined is too small for it to be significant.¹⁰ The subject described in this article is a 25-year-old, intact female. In the literature, only a few cases of paraparesis or paraplegia are reported in the bear: three cases of myelitis of viral origin in the polar bear, two cases of rabies diagnosed post-mortem in wild subjects and one case of West Nile viral infection in a captive subject.¹¹⁻¹³ In other reports, this symptoms were described as a result of spinal cord compression: disc extrusion,^{2,4} disc extrusion with subdural hemorrhage,³ vertebral exostosis,⁹ ganglion cyst,¹⁴ ligamentum flavum hypertrophy.^{10,14,15} Of the cases described, only three were disc extrusions and of these only one was treated surgically.²⁻⁴ Two patients with ligament hypertrophy underwent a successful decompressive surgery.^{10,15} All the reports describe exclusively paraparetic subjects, with the exception of a case of an American brown bear which also had intermittent lameness of a thoracic limb.¹⁴ The Marsican bear described in this study is the only subject presenting tetraparesis (Table 1). In the bear the identification of the neuroanatomical localization of the lesion may be difficult due to the impossibility of performing a complete neurological ex-

amination; when multiple lesions are detected by imaging, the interpretation could be problematic,^{3,14,15} moreover, the large size of bears makes diagnostics and surgery difficult.¹⁰ The patient described in this article had 7 cervical, 14 thoracic and 6 lumbar vertebrae, while in another reported study a European brown bear had 7 cervical, 15 thoracic and 6 lumbar vertebrae.³ The CT examination revealed extensive spondylosis, as reported in older bears.^{3,4} MRI is considered the examination of choice for the study of the central nervous system in both human and veterinary medicine, but in most of the bear cases de-

In the literature, reports of surgeries performed on bears include: one thoracic dorsal hemilaminectomy for a herniated disc and two thoracic and lumbar dorsal laminectomies for the thickening of the ligamentum flavum.

scribed in the literature CT scans, myelo-CT, myelography or direct X-rays were performed, due to the unavailability of diagnostic equipment suitable for the size of the patients.^{3,14} In the literature, two works are described in which MRI was used: in an American black bear weighing 150 kg, investigated using a 3T MRI machine⁴ and in two American brown bears weighing 250 and 263 kg, using a 1T MRI machine; in this last study, problems were reported in the execution of the examination in view of the size of the animal, which did not allow the acquisition of diagnostic images.¹⁴ In the literature, only three works described the findings of CSF analysis in the bear and all assumed that the normal bear values were similar to those reported in other species;^{10,14,16} the values found in our patient were con-

sidered normal.

In all of the works described medical therapy, possibly associated with physical activity restriction, was unable to improve the symptomatology, as in the case presented here.^{3,10,14,15} Four patients underwent euthanasia following failure of conservative therapy or because of the poor prognosis.^{3,4,9,14} Three bears underwent a successful decompressive surgery: an American brown bear that underwent hemilaminectomy for a disc extrusion at T10-T11;² a Syrian bear and a polar bear that underwent dorsal laminectomy with removal of the thickened ligamentum flavum at T2-T3 and L3-S1, respectively.^{9,15} Given the absence of studies describing neurosurgery procedures in large carnivores, the present work and those already presented in the literature report on the use of surgical techniques used in human medicine and in the dog.^{2,5,10,15}

Despite the duration of the clinical signs before the pa-

tient underwent the surgical procedure, the post-operative recovery at four months was complete.

The CT scan showed the presence of a herniated cervical disc; the patient underwent a ventral slot decompression surgery, using the same approach used in the dog.

To the knowledge of the authors, this is the first work describing a herniated cervical disc and a ventral slot surgical treatment in a bear, demonstrating that the procedure can be performed in this species and that the surgical approach is similar to the one described in the dog.

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KEY POINTS

- In the literature there are only few reports of paresis/paraplegia in the bear; in the cases reported, the symptomatology was caused by viral or compressive disorders, with spinal cord involvement (herniated disc, exostosis, ganglion cyst or thickening of the ligamentum flavum).
- Conservative therapy was not effective in the treatment of spinal cord compressive diseases while surgery, when performed, allowed functional recovery.
- The surgical techniques used in the cases described in the literature as well as in the patient of this paper are the same as those used for neurosurgery in the dog. To the knowledge of the authors, a herniated cervical disc in a bear has never been previously reported.

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