Successful conservative management of epidural gas accumulation and haematoma formation following a lateral corpectomy in a dog.

Received: 18 April 2022 | Revised: 26 October 2022 | Accepted: 9 December 2022

DOI: 10.1002/vrc2.558

Vet Record CaseReports

CASE REPORT

Laboratory animals

Successful conservative management of epidural gas accumulation and haematoma formation following a lateral corpectomy in a dog

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Abstract

A 9-year-8-month-old, male, neutered labrador crossbreed dog was presented for evaluation of a chronic, progressive pelvic limb ataxia and thoracolumbar hyperaesthesia. The patient was diagnosed with a T12–T13 intervertebral disc protrusion and treated surgically with a lateral corpectomy procedure. After an initial post-operative improvement, the dog acutely deteriorated to the point of severe non-ambulatory paraparesis, with recurrence of thoracolumbar hyperaesthesia. A computed tomography scan revealed the presence of epidural gas accumulation and haematoma at the corpectomy site, causing moderate spinal cord compression. The patient was treated conservatively with strict rest and analgesia with subsequent neurological improvement. At the recheck appointment 6 weeks after surgery, the dog had demonstrated improvement from its pre-surgical neurological status.

KEYWORDS
dogs, neuroimaging, neurosurgery

BACKGROUND

Symptomatic epidural gas accumulation (EGA) is an unusual complication of spinal surgery (e.g., microdiscectomy procedures) in human patients.[1–8] The mechanism of EGA following such procedures is unclear. A commonly proposed theory involves the release of pre-existing intradiscal gas, or the creation of an intradiscal cavity, which allows air accumulation within the epidural space via a vacuum phenomenon.[1–3,5,7] Others suggest that atmospheric gas becomes encapsulated within the soft tissue planes as a result of intraoperative haemorrhage.[6] In humans, discectomy procedures are most commonly performed in the lumbosacral region. As such, patients with symptomatic EGA commonly display symptoms associated with a lumbar radiculopathy (e.g., pain, weakness, numbness or tingling) after an initial period of post-operative improvement.[1–8] Diagnosis is confirmed using a combination of computed tomography (CT) and magnetic resonance imaging (MRI) to rule out other causes of acute deterioration, including haematoma formation or further herniation of the affected intervertebral disc.[6] Conservative treatment with strict bed rest, opioid analgesia and anti-inflammatory medication is routinely recommended. However, approximately 50% of patients will require surgical decompression or CT-guided aspiration.[7]

Published reports of symptomatic EGA following spinal surgery in veterinary patients are sparse and limited to a total of two dogs.[9,10] Both cases were treated surgically with successful outcomes. As such, it is currently unknown whether conservative treatment represents a valid option for veterinary patients experiencing this complication. To our knowledge, this case report represents the first description of successful conservative management of EGA following spinal surgery. We also describe the interesting pre-operative imaging finding of intradiscal gas, and propose this finding as a potential risk factor for EGA in canine patients undergoing intervertebral disc surgery. By contributing to the existing veterinary literature, we aim to raise awareness of this rare neurosurgical complication and encourage it to be included as a differential diagnosis in dogs experiencing an acute neurological deterioration following spinal surgery.

CASE PRESENTATION

A 9-year-8-month-old, male, neutered labrador crossbreed dog was referred to the Neurology and Neurosurgery Service (Hospital for Small Animals, Royal [Dick] School of Veterinary Studies) for assessment of a chronic progressive pelvic limb ataxia and spinal hyperaesthesia refractory to

multimodal analgesia and strict rest. The physical examination was unremarkable except for findings consistent with osteoarthritis affecting the right elbow joint. The neurological examination revealed marked kyphosis, marked proprioceptive ataxia affecting the pelvic limbs, severely delayed to absent paw replacement in the pelvic limbs, normal spinal reflexes and marked hyperaesthesia and crepitus on palpation of the thoracolumbar junction. Additionally, there was mild hyperaesthesia on palpation of the lumbosacral region. These findings were consistent with a neurolocalisation to the T3–L3 spinal cord segments and the lumbosacral region (including the soft tissue structures, vertebral periosteum, articular joints, annulus of the intervertebral disc, meninges and nerve roots). Differential diagnoses included a degenerative (e.g., intervertebral disc disease [Hansen type II]), neoplastic (e.g., primary or secondary spinal cord tumour) or infectious (e.g., discospondylitis with secondary empyema) condition. Further investigations (i.e., advanced imaging) were recommended.

INVESTIGATIONS

An MRI study of the thoracolumbar vertebral column revealed a chronic, moderately compressive ventrocentral intervertebral disc protrusion at the level of T12–T13, with T2-weighted hyperintense signal changes within the spinal cord at this level, consistent with gliosis or oedema (Figure 1a). The nucleus pulposus of the T12–T13 intervertebral disc contained a well-defined, smoothly marginated, ovoid T2-weighted and short tau inversion recovery (STIR) hypointense structure, consistent with a vacuum phenomenon (Figure 1b). The T12–T13 articular joints exhibited marked degenerative changes causing mild bilateral dorsolateral compression of the spinal cord. Mild degenerative lumbosacral disease and multifocal intervertebral disc degeneration with multiple non-compressive intervertebral disc protrusions were also present. Due to the progression of the patient's neurological signs, surgical treatment was recommended.

LEARNING POINTS/TAKE-HOME MESSAGES

- Epidural gas accumulation is a rare surgical complication following spinal surgery in veterinary patients.
- Epidural gas accumulation should be considered as a differential diagnosis for acute neurological deterioration in post-operative spinal patients.
- Conservative treatment may provide a successful outcome when surgical treatment is not possible.
- The presence of intradiscal gas/vacuum phenomenon may be a risk factor for epidural gas accumulation.

TREATMENT

A T12–T13 right-sided lateral corpectomy was performed without complications. The corpectomy site was flushed thoroughly with saline before closure. A free fat graft or cellulose/gelatin membrane was not placed within the corpectomy defect. The patient recovered uneventfully from general anaesthesia, exhibiting a mild neurological deterioration in the immediate post-operative period to non-ambulatory paraparesis with excellent voluntary motor function in both pelvic limbs. Over the subsequent 48 hours, the patient continued to improve to the pre-surgical neurological status, with pain being well controlled. On the third post-operative day, the patient acutely deteriorated to the point of severe non-ambulatory paraparesis with minimal voluntary motor function in the pelvic limbs and worsening spinal hyperaesthesia. Radiographs of the thoracolumbar vertebral column were performed under sedation to rule out a vertebral luxation. No radiographic findings consistent with vertebral instability were noted. Subsequently, a CT examination of the thoracolumbar vertebral column was performed, which revealed a large hypoattenuating (−879 Hounsfield units [HU]) area compatible with gas, located within the corpectomy site and

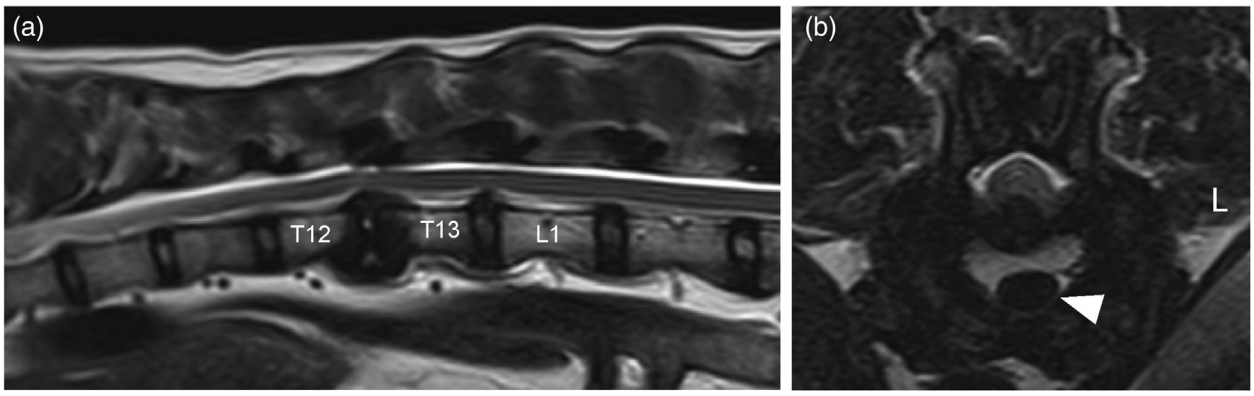

FIGURE 1 Pre-operative T2-weighted magnetic resonance imaging study of the thoracolumbar vertebral column. L: left. (a) Sagittal image reveals the presence of degenerative changes to the caudal endplate of T12 and cranial endplate of T13 with associated ventral bridging spondylosis. The ventral epidural fat/cerebrospinal fluid column is dorsally displaced by an intervertebral disc protrusion at this level. Mild intramedullary T2-weighted hyperintense signal is present within the adjacent spinal cord. Degenerative changes affecting the articular facet joints are also visible, causing partial attenuation of the dorsal epidural fat/cerebrospinal fluid column. (b) Transverse section through the T12–T13 intervertebral disc demonstrates the ventrocentral intervertebral disc protrusion and presence of air (vacuum phenomenon) (white arrowhead) within the ventral central portion of the nucleus pulposus.

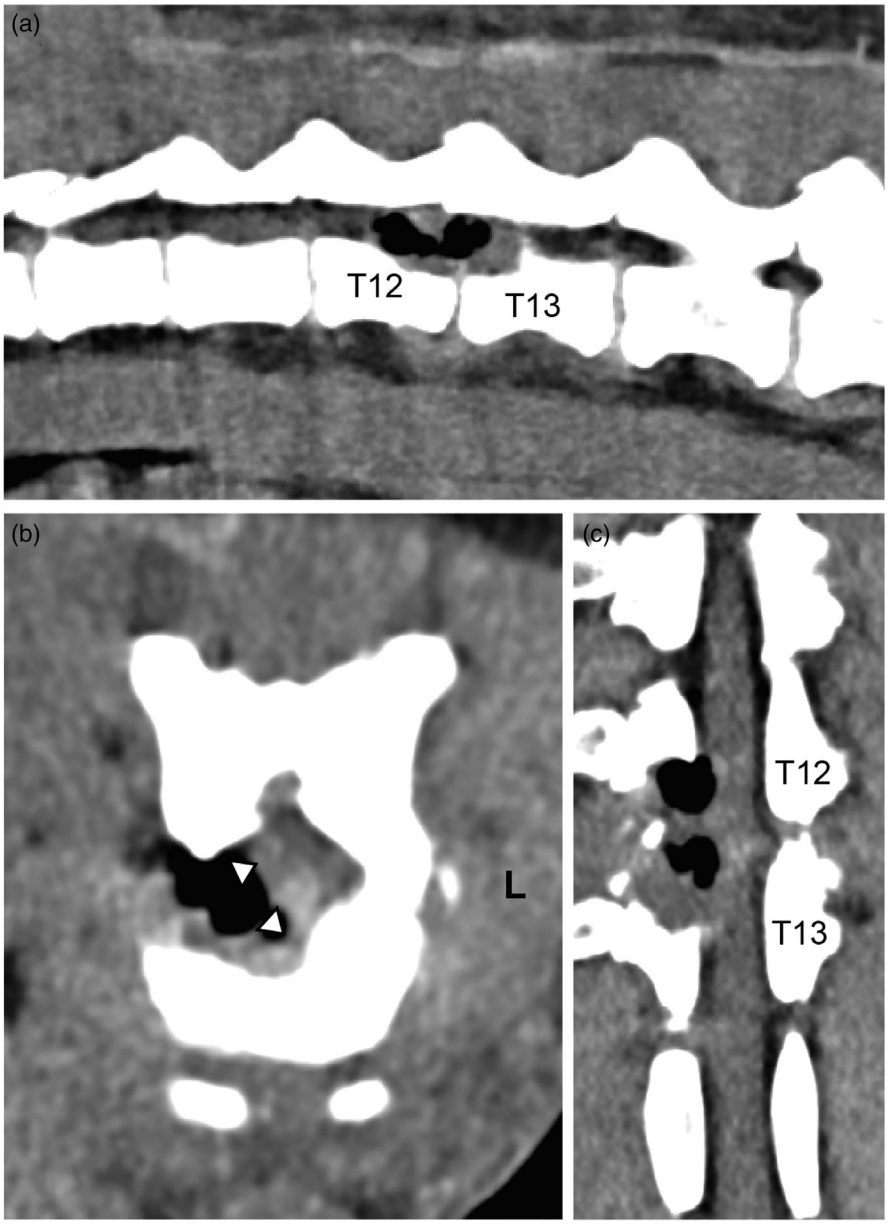

FIGURE 2 A computed tomography (CT) imaging study obtained 72 hours following surgery. The soft tissue window pre-contrast administration images are provided. L: left. (a) Sagittal CT images at the level of the corpectomy site at T12–T13, centred on the hypoattenuating (−879 HU) area. This finding is consistent with epidural gas accumulation. (b) Transverse CT images at the level of the cranial end plate of T13 demonstrating the epidural gas adjacent to a hyperattenuating (134 HU) area in the extradural space (white arrowheads) causing compression of the spinal cord at this level. This finding is consistent with haematoma formation. (c) Dorsal CT images at the level of the T12–T13 corpectomy site centred over the level of epidural gas accumulation

the adjacent vertebral canal. Adjacent to the gas and contributing to compression of the spinal cord at this level was a well-defined hyperattenuating (134 HU) area consistent with a haematoma (Figure 2a–c). The intradiscal gas that was present at the T12–T13 intervertebral disc space on the pre-surgical MRI study was no longer present. The combination of EGA and haematoma formation was deemed to be the cause of the patient's acute neurological deterioration. The option of revision surgery was discussed with the owners, but due to limited access to theatre because of other vital emergencies and the owners' reluctance to pursue further invasive treatment, it was elected to assess the patient's response to 24 hours of conservative management. Treatment with strict cage rest and escalated analgesia was initiated. The subsequent day, a mild improvement in the patient's neurological status was observed and its pain was well controlled. As neurological improvement had been noted, we elected to continue conservative treatment. The patient continued to improve and was discharged from the hospital 4 days later to receive oral analgesia and cage rest at home. At the point of discharge, the patient was minimally ambulatory paraparetic with excellent voluntary motor function in both pelvic limbs and a marked proprioceptive ataxia.

OUTCOME AND FOLLOW-UP

The patient returned for a post-operative recheck examination 6 weeks later. The owners reported a significant improvement in the patient's pain level (compared to before surgery) and an improvement in the degree of kyphosis and paraparesis since its initial discharge from the hospital.

On examination, the patient exhibited a mild kyphosis, mild ambulatory paraparesis with moderate to marked proprioceptive ataxia affecting the pelvic limbs, delayed paw replacement in both pelvic limbs, marked symmetrical muscle atrophy affecting the pelvic limbs and mild hyperaesthesia at the surgical site. Ongoing analgesia, physiotherapy and a gradual increase in exercise were recommended. On review during a physiotherapy appointment 2 months later, the patient was strongly ambulatory and able to exercise for 30 minutes. Posture and muscle mass had improved significantly, but a moderate pelvic limb proprioceptive ataxia remained.

DISCUSSION

In this case report, we describe EGA and haematoma formation as the cause of neurological deterioration following a lateral corpectomy to treat a chronic intervertebral disc protrusion in a dog. We provide the first description of conservative management of this neurosurgical complication and discuss how our findings contribute to the existing literature surrounding this uncommon condition.

In the veterinary literature, reports of EGA following spinal surgery are limited to two dogs. Cornelis et al. described symptomatic EGA and haematoma formation in a dog 48 hours after a hemilaminectomy procedure to treat an acute intervertebral disc extrusion. In another study, Skytte and Schmökel described EGA as the cause of recurrent lumbosacral pain in a dog, 3 years after a dorsal laminectomy for treatment of a lumbosacral intervertebral disc protrusion. In both cases, EGA was managed with surgical treatment and both dogs made a full neurological recovery. Our case draws similarities to that of Cornelis et al., with both dogs experiencing a severe neurological deterioration following thoracolumbar surgery to treat intervertebral disc disease. In contrast to human patients, surgical treatment for intervertebral disc disease in canine patients is more commonly performed in the thoracolumbar rather than the lumbosacral region. As such, post-operative EGA is more likely to result in more severe neurological deficits in canine patients. For this reason, it is not accurate to extrapolate management recommendations for our patients from the human literature, in which conservative treatment of EGA is prioritised. In veterinary medicine, revision surgery is usually recommended when patients experience an acute and severe neurological deterioration following spinal surgery. Indeed, this approach was taken by Cornelis et al., and would have been justified in the management of the case we report. However, as our patient responded positively to an initial period of conservative management, we felt that it was warranted to continue with this approach. It is possible that the neurological recovery of our patient may have been quicker had surgical treatment to remove the epidural gas and haematoma been performed. However, due to the chronicity of the patient's intervertebral disc protrusion, we had not anticipated a hasty neurological recovery and we were pleased with the rate of improvement that our patient displayed. Finally, we do not routinely cover our laminectomy or corpectomy site with a free fat graft or gelatin/cellulose membrane as the evidence for this practice remains unclear in veterinary medicine.[11,12] Furthermore, manufacturers recommend that haemostatic agents are removed from the laminectomy site once adequate haemostasis has been achieved, to reduce the risk of secondary compression on the surrounding neural structures.[13] It is difficult to predict whether placement of a haemostatic agent into the corpectomy defect could have been beneficial in this case, as although it may have helped with ongoing haemostasis, the sponge swelling may have contributed to secondary spinal cord compression.

Interestingly, in human studies, the presence of intradiscal gas (i.e., vacuum phenomenon) is purported to act as a source of EGA following discectomy procedures.[1–3,5,7] Intradiscal gas, composed mostly of nitrogen, accumulates within the fissures of degenerated intervertebral discs as a result of vacuum phenomenon—the movement of gas from the venous circulation into an area of lower or negative pressure.[14] Indeed, intradiscal gas is a common finding in canine patients with intervertebral disc disease and is mostly considered to be an incidental finding.[15] While spontaneous EGA has been associated with the presence of intradiscal gas in two dogs,[10,16] there are no reports of intradiscal gas as an imaging finding in cases which experience EGA as a neurosurgical complication.[9,10] As such, we propose that the presence of intradiscal gas may represent a risk factor for EGA in veterinary patients undergoing intervertebral disc surgery.

In summary, we describe the successful conservative management of symptomatic EGA following lateral corpectomy in a dog and discuss the existing veterinary literature surrounding this neurosurgical complication. Due to lack of available evidence, it is not possible to determine whether conservative treatment for symptomatic EGA following intervertebral disc surgery provides a comparable outcome to surgical treatment and decisions regarding treatment should continue to be made on a case-by-case basis. While surgical treatment should be strongly considered in patients exhibiting a severe neurological deterioration, we demonstrate that conservative management may provide a successful outcome in clinical situations where this is not feasible.

AUTHOR CONTRIBUTIONS

Megan Madden and Kiterie Faller managed the case from initial presentation to surgical treatment and facilitated follow-up revisits. Callum Atkins and Zohra Khan managed the case following surgery and during the post-operative deterioration. Nicolas Israeliantz and Tiziana Liuti reported and interpreted all imaging studies. The manuscript was written by Megan Madden, with equal contributions from all authors during the revision process.

CONFLICT OF INTEREST

The authors declare they have no conflicts of interest.

FUNDING INFORMATION

The authors received no specific funding for this work.

ETHICS STATEMENT

No ethical approval was required.

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How to cite this article: Madden M, Atkins C, Khan Z, Israeliantz N, Liuti T, Faller K. Successful conservative management of epidural gas accumulation and haematoma formation following a lateral corpectomy in a dog. Vet Rec Case Rep. 2023;e558. https://doi.org/10.1002/vrc2.558

MULTIPLE-CHOICE QUESTION

Which of the following options are potential causes of epidural gas accumulation?

POSSIBLE ANSWERS TO MULTIPLE-CHOICE QUESTION

a) Trauma
b) Pyogenic infections
c) Pneumothorax
d) Vacuum phenomenon
e) Iatrogenic (e.g., via epidural injection, surgical complication)
f) All of the above

CORRECT ANSWER

f) All of the above

All of the above have been reported as causes of epidural gas accumulation in human medicine. In veterinary medicine, epidural gas accumulation (i.e., pneumorrhachis) has been reported alongside pneumocephalus following craniotomy/rhinotomy procedures and traumatic head injury, or independently as a spontaneous event or following a spinal surgery.