Pneumorrhachis in a cat: case study and a literature review

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Subarachnoid pneumatosis.

Summary
A three-year-old domestic shorthair cat was referred for treatment of pelvic limb paralysis. Imaging examinations revealed air in the spinal canal (pneumorrhachis). A right-sided hemilaminectomy was performed to decompress the spinal cord, which led to full resolution of the symptoms within four weeks after the procedure.

To our knowledge, this is the first reported case of spontaneous pneumorrhachis in a cat. As there are no treatment standards, we would like to add to their creation. The available literature on pneumorrhachis has also been reviewed.

Introduction

Pneumorrhachis (PR) refers to the presence of gas in the spinal canal and the epidural or subdural spaces. The aetiologies underlying this phenomenon are categorised as iatrogenic, traumatic, or non-traumatic. The most commonly reported cause of PR is trauma, which may be associated with pneumocephalus, cranial pneumothorax, fracture or displacement of the spine, pelvic trauma and blunt chest trauma. Non-traumatic causes include gas formation in degenerative intervertebral discs (VP) after migration to the channel causing secondary induction of PR, gas from synovial cysts and gas production by epidural abscesses. Iatrogenic PR may occur after epidural injections or as a complication of spinal cord decompression.

PR is a rare phenomenon in animals and humans. Spontaneous PR, which causes clinical signs of spinal cord pressure, as well as PR as an iatrogenic complication of the treatment process, have been observed in dogs. However, in cats, only one case of iatrogenic PR has been described, with no studies assessing the relationship between PR and clinical symptoms or defining treatment standards. As a result of these gaps in the literature, interpretations of such changes in imaging studies and their relationships with symptoms is not always unambiguous. This paper describes the clinical course and treatment outcomes in a cat with spontaneous PR of the thoracic spine and clinical signs of paresis of the limbs. The literature in the Medline database was also reviewed for the term pneumorrhachis in a dog/cat, and the related keywords intraspinal air in a dog/cat, spinal pneumocele in a dog/cat and subarachnoid pneumatosis in a dog/cat. The search criteria yielded 8 studies, and the literature on the selected studies was also reviewed.

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Materials and methods

A three-year-old female sterilised domestic shorthair cat was referred for the treatment of behavioural disorders and impaired motor coordination. The cat had been adopted six months before the visit. The owner mentioned that the cat had been always less active than other cats, and for two weeks, it avoided jumping and did not allow herself to be stroked, especially in the area of the thoracic spine. It had difficulty maintaining balance, and three days before the visit, the owner noticed intensifying paresis of the hind limbs, which tended to periodically withdraw and relapse.

During the presentation the cat was conscious, took a hunched position, and moved with the help of the thoracic limbs pulling the pelvic legs behind it. No muscle atrophy was found and the cat reacted with aggression to the palpation of the thoracic region. The muscle tension was lowered in the thoracic and lumbar spine muscles, and in the pelvic limbs. The internal temperature measured in the rectum was 38,3 ° C. Neurological examination showed correct postural reactions and spinal reflexes in the thoracic limbs. In the pelvic limbs the proprioceptive placement, hopping and positioning reactions were weakened. The withdrawal reflexes were weakened and the patellar and tibial reflexes were intensified. The perineal reflex was weakened and the skin reflex was weakened caudally from Th4. No cranial nerve deficits were found. Based on the neurological examination paresis of the pelvic limbs was stated and it was assumed that the damage is located in the segment between Th4-L3. The blood count and serum biochemical profile results were within the normal range. Imaging of the thoracic spine was performed using the following anaesthesia protocol: premedication, butorphanol 0.4 mg/kg, IM (Butomidor; Richter Pharma, Austria) and medetomidine 0.4 mg/kg (Cepetor; CP Pharma Handelsgesellschaft mbH, Deutschland); induction, propofol 1 mg/kg (Proposure; Corden Pharma S.p.A., Italy); maintenance, continuous infusion of propofol at 1 mL/1 kg/1 h. The overall X-ray examination was performed using a diagnostic X-Ray Unit (Orange 1040HF, AcuMed Group, London, United Kingdom; KOR; 48 kV and 8.5 mAs in left lateral and ventrodorsal projections). X-ray images of the thoracic spine showed subtle, diffuse changes in the area of the boundary plates of the vertebrae in the Th5-Th6 segment, thickening of the shadow in the Th5-Th6 intervertebral space, and in the projection of the Th5-Th6 intervertebral foramen. To expand the diagnostic spectrum, a native examination was performed with myelography of the thoracic spine using cone-beam computed tomography (CBCT) with NewTom 5GXL Vet (I) (Inline Systems Pty Limited, Australia, 110 kV, 31 mA). The myelographic study was performed using iohexol (Omnipaque 240; GE Healthcare, Ireland) at a dose of 0.3 mL/kg body weight administered to the trunk with a large lumbar puncture needle (Spinocan 20G). During the puncture, before contrast was administered, CSF was obtained for bacteriological culture with an antibiogram and for cytological tests. The results of cerebrospinal fluid analysis were normal (2 cells/µL), and the culture did not show any growth. After the MRI, blood and urine samples were taken for cultures and UrinUrine culture showed an increase in Staphylococcus aureus (coagulase-positive) that was sensitive to fluoroquinolones, clindamycin, cephalexin, marbofloxacin, metronidazole, and erythromycin. The CBCT study was performed using radiant DICOM Viewer 5.0.2 software with a bone window, 3DMPR reconstruction, and MPR and MinIP modes. CBCT showed that degenerative changes in intervertebral discs reduced the height of the discs in the Th1–Th10 intervertebral spaces. In addition, PR was observed in the epidural space in the spinal canal at the height of the Th5 and Th6 spaces (Figs. 1-3). PR appeared in the form of two gas pockets with dimensions of 1.95 mm × 1.85 mm × 1.94 mm (-927 HU; Fig. 1.1) and 1.45 mm × 0.95 mm × 0.96 mm (-822 HU; Fig. 1.2). Myelographic examinations showed a blurred image of the previously diagnosed gas pockets in the spinal canal.

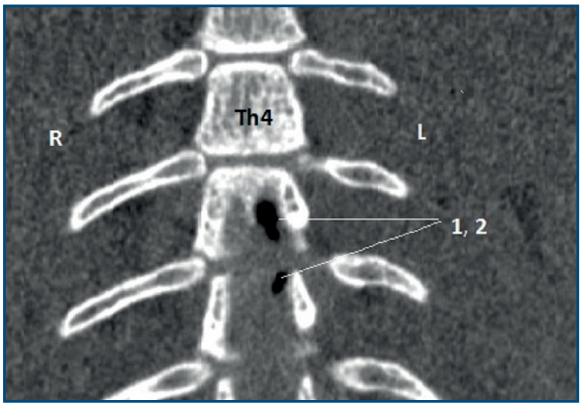

Figure 1. *CBCT study, frontal reconstruction, bone window, at the level of Th4-Th6*

Figure 2. *CBCT study, transverse reconstruction, bone window, at the level of Th4-Th6*

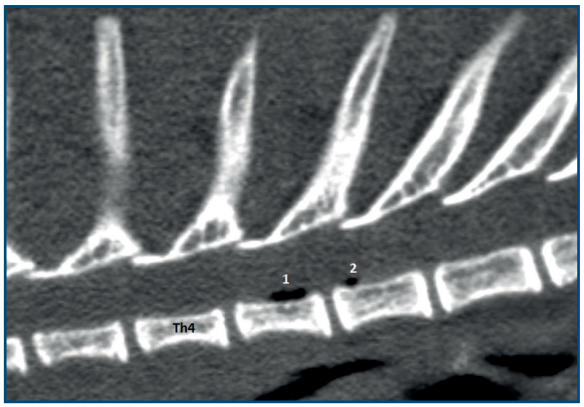

Figure 3. *CBCT study, saggital reconstruction, bone window, at the level of Th4-Th6*

On the basis of the medical history, clinical symptoms, and imaging results, spinal decompression with a right-sided hemilaminectomy at the Th5/6 level was planned according to the technique described by Bray *et al*. Before the procedure, the cat was intravenously administered a single dose of dexamethasone 2 mg/kg (Rapidexon; Eurovet Animal Health B.V., Netherlands). The same anaesthesia protocol described earlier was used, and was supplemented with fentanyl (50 µ/mL; Fentadon Vet., Eurovet Animal Health B.V., Netherlands) at a dose of 5 µg/kg/h, ie. 0.1 mL/kg/h. After creating a window on the side of the Th5 arc, the yellow ligament was incised and removed. The protruding masses of the Th5-Th6 vertebral discs were removed from the lateral spinal canal. No stabilisation method was used during the surgery. After hemilaminectomy, Spongostan Special 7 × 5 × 0.1 cm (Ethicon, Johnson & Johnson, USA) was placed above the hemilaminectomy window, in the soft tissues. After flushing the operating field with Ringer's solution (Solutio Ringeri Lactate; Fresenius Kabi Polska sp. Z.o.o., Poland), routine closure of the fascia, subcutaneous tissue, and skin was performed. A Staphylococcus aureus strain that primarily showed sensitivity to fluoroquinolones and clindamycin was isolated from the tissue mass removed from the spinal canal. Histopathological examination of the removed intracanal masses revealed the presence of vitreous cartilage and fibrous tissue. For a period of 4 weeks after the procedure, the cat was administered clindamycin 5.5 mg/kg, 2x dz., PO (Aniclindan 75; aniMedica GmbH, Deutshland) and enrofloxacin 5 mg/kg, 1x dz., PO (Enroxil Flavour 15; KRKA d.d., Slovenia). For analgesic protection, gabapentin (Summit Veterinary Pharmaceuticals, Great Britain) 3 mg/kg BW, PO every 12 hours for 3 days and meloxicam (Metacam; Boehringer Ingelheim, Great Britain), 0.05 mg/kg BW, PO for 5 days were administered. After the procedure, cage detention was performed for 2 weeks. On the day following the operation, deep sensation and weak movements of the pelvic limbs were observed. At that time, the cat showed urinary incontinence, and its gait was characterised by right-sided collapse and foot-likeness. Daily massage and passive movement of the hind legs were performed to support the treatment. The condition of the cat improved gradually. On the third day after the procedure, control over urination returned. The cat's well-being improved from the third day and was correlated with the disappearance of neurological symptoms. Pelvic limb proprioception disorders persisted for up to seven days after surgery. After four weeks of treatment, the neurological deficits disappeared completely, and according to the owner, the cat appeared to be feeling good. The owner did not agree to a follow-up CT examination. On the seventh postoperative day, the cat was discharged with slight residual paresis.Complete resolution of the disease symptoms and return of animal welfare were noted after two months. No disease recurrence was observed during the 12-month follow-up.

Discussion

PR in animals has rarely been described, mainly because imaging examinations in animals are usually performed only in patients with visible clinical symptoms (paresis) while those in human beings are performed even in cases with moderately intensified pain symptoms. Of the various causes of PR described in dogs and cats, spontaneous PR is the most common (five cases). Iatrogenic PR has been described in four cases, three of which were caused by spinal cord decompression procedures and one was a consequence of epidural anaesthesia. One case was caused by injury to the thoracic spine. PR was localised in the thoracic spine in seven patients, in the lumbosacral region in four, and in the cervical region in one.

Since the previously reported cases in animals showed clinical symptoms while PR in human beings is most often asymptomatic, the mere occurrence of gas in the canal can be assumed to rarely cause changes severe enough to induce significant clinical symptoms. Therefore, establishment of other pathologies existing with PR (degenerative discopathy, stenosis, inflammation, ischaemia, etc.) is of major importance for proper treatment. In the previously described cases of PR, surgical treatment was performed regardless of the concomitant pathology and cause (spontaneous or iatrogenic). In the case described by Macdonald and others, PR was the main lesion, resulting in approximately 30% core compression, and was diagnosed in a dog with progressive paresis and impaired deep sensation in

the pelvic limbs. A dorsolateral hemilaminectomy was performed, and the gas was removed from the pocket formed in the peripenal fat. Over the next three months, the dog gradually recovered. The decision to perform the procedure was made because of the progressive nature of the disease, and the results of the treatment were positive. In cases involving spontaneous PR, only one of the papers described conservative treatment that was initially performed in a dog with poorly expressed clinical symptoms. Nonsteroidal anti-inflammatory drugs were administered for 6 weeks, and rest was recommended. When treatment did not yield any results, CT of the spine was performed. Osteochondronic changes in the spinal canal and gas pockets were observed. Subsequently, laminectomy and partial discectomy were performed. Six weeks after the procedure, the symptoms disappeared completely and no changes were observed in the spine on the follow-up CT scan.

Surgical treatment was also used in another case of iatrogenic PR. In that case, PR was reported in a dog secondary to right-sided hemilaminectomy due to prolapse of the intervertebral disc. The patient's condition did not improve postoperatively; therefore, a control CT scan was performed, and spinal compression caused by the occurrence of PR and hematoma was diagnosed. Another operation was performed, and the hematoma was removed; however, no gas pocket was found. The dog recovered completely within five months after the procedure.The symptoms in the patient in this study were primarily attributable to compression of gas pockets and, most likely, ischaemic changes against this background. Imaging studies did not show significant compression caused by degenerative changes, nor were there any typical inflammatory lesions of the spondylodiscitis type.

Conclusions

PR in animals is relatively rare. Advancements in diagnostics and more frequent use of imaging tests in animals will certainly facilitate more frequent observations of this phenomenon. Therefore, the appearance of PR in imaging studies should not be underestimated. The pathology that may have led to the formation of PR should be clarified to facilitate appropriate treatment and is essential for obtaining good therapeutic outcomes. The decision on the type of treatment is justified by the clinical condition. In cases showing paresis, surgical decompression is indicated.

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