

CASE REPORT

Companion or pet animals

Compressive hydrated nucleus pulposus extrusion in a dog

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Abstract

An 8-year-old female neutered Maltese Bichon Frise was presented to a small animal hospital for assessment of acute paraplegia. Diagnostic imaging including plain spinal radiographs and CT angiography was neither suggestive of an intervertebral disc extrusion nor any other abnormalities could be detected. The dog was referred to the emergency service of a specialty hospital for an MRI scan. The MRI showed features of a hydrated nucleus pulposus extrusion (HNPE) at L2-3. Subsequent hemilaminectomy identified a mixture of white gelatinous and partly firm material. Cytology and histology were consistent with a partially degenerated nucleus pulposus. Compressive HNPE of the lumbar spine was diagnosed. The dog was discharged 5 days postoperatively. At the last follow-up conducted by phone interview (2 months postoperatively), the owner reported normal ambulation without any signs of neurologic deficits.

BACKGROUND

Intervertebral disc disease (IVDD) is the most common cause of acute paralysis in chondrodystrophic dogs presenting to small animal emergency clinics.¹ IVDD generally encompasses intervertebral disc extrusions (IVDEs) and protrusions. IVDEs can further be subclassified into five types, including the hydrated nucleus pulposus extrusion (HNPE).² HNPE mostly affects the cervical spine, with only four cases reported at T13-L1.³⁻¹¹ CT is considered adequate as the first-line imaging modality in chondrodystrophic dogs, requiring additional imaging, such as myelography, CT-myelography and/or MRI, in only 3.6% of these breeds.¹² In contrast, false-negative results diagnosing IVDE are less likely with MRI, and the risks associated with myelography are avoided.¹³ Successful outcomes after medical and surgical treatment have been reported. Due to the assumption of rapid resorption or dispersion of the extruded nucleus pulposus, conservative management of HNPE in the cervical and thoracolumbar spine may represent a viable alternative to surgery.^{10,11} At the time of submission of this case report, thoracolumbar HNPE was not reported, and no histological evidence supported HNPE in the canine thoracolumbar spine. Recently, another group published a study describing thoracolumbar HNPE and comparing them to cervical HNPE.¹⁴ To further contribute to this new condition in a relatively small number of cases, this case report describes the presentation, diagnostic imaging, management and outcome for a dog with compressive HNPE in the lumbar spine.

CASE PRESENTATION

An 8-year-old female neutered Maltese Bichon Frise (Bichon Frise and Maltese dog) weighing 11 kg was referred to the emergency service at the Ludwig-Maximilians University. The dog was initially seen earlier that day by a small animal hospital for assessment of acute paraplegia. IVDE was suspected. Complete blood count (CBC), serum biochemistry, orthogonal radiographs and CT angiography of the spine were performed. CBC and serum biochemistry were unremarkable. Diagnostic imaging was neither suggestive of an IVDE nor any other abnormalities could be detected, and the dog was referred for an MRI scan.

INVESTIGATIONS

The general examination was unremarkable. Neurological examination revealed paraplegia (Grade 2 modified Frankel score) and the lesion was suspected to be localised at the thoracolumbar spinal cord segment (T3-L3) with lateralisation to the right side. The dog had urinary retention. Radiographs and CT performed before referral were reviewed. The radiographs demonstrated no supportive changes for IVDE. A helical multiple slice CT (Somatom Scope, Siemens Medizin-technik/Healthineers) was used for the examination. All series were conducted with 110 kV/130 mAs and a slice thickness of 1 mm. The convolution kernel of the bone window was 'B80s' (high-frequency image reconstruction algorithm) with a

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window level of 300 and a window width of 2300. The convolution kernel of the soft tissue window was 'B31s' (low-frequency image reconstruction algorithm) with a window level of 46 and a window width of 320. Attenuation was measured in soft tissue reconstruction, and a mean attenuation of 41 Hounsfield units (HU) with a range of ± 10 HU was detected. CT revealed no characteristics of acute IVDE (Figure 1). Advanced standard protocol MRI (1.5T) was performed (sagittal, transverse and dorsal T2-weighted [T2w]; transverse pre- and postcontrast T1w and subtraction; transverse T2*w; transverse short tau inversion recovery (STIR)). MRI demonstrated a broad-based ventral extradural compressive homo- to heterogeneous IVDE above the intervertebral disc space with slight right-sided lateralisation tapering off in a cranial and caudal direction. The material showed a hyperintense signal with iso-hypointense foci on T2w images, an iso-hypointense signal on T1w images, was hyperintense in the T2*w images and hyperintense on STIR images. The affected disc space showed a reduced volume of nucleus pulposus and a partly degenerated nucleus pulposus. There was a loss of the hyperintense signal associated with subarachnoid and epidural spaces. The extruded material demonstrated variable degrees of contrast enhancement. The degree of spinal cord compression accounted for 51% in the transverse planes. Based on imaging findings, a compressive, lateralised HNPE at the second to third lumbar intervertebral disc space was suspected (Figure 2).

DIFFERENTIAL DIAGNOSIS

The most common cause for a chondrodystrophic dog presenting with acute paraplegia is IVDE. Other aetiologies may include non-compressive disc extrusion (e.g., acute non-compressive nucleus pulposus extrusion (ANNPE)), infection, trauma, degenerative disease, haemorrhage, ischaemic injury (e.g., fibrocartilaginous embolic myelopathy (FCEM)), congenital malformations and neoplasia. Based on the MRI findings, the primary differential diagnosis for this case was HNPE.

LEARNING POINTS/TAKE-HOME MESSAGES

- MRI offers more information than CT \pm contrast for the assessment of intervertebral disc extrusion regardless of the breed.
- Hydrated nucleus pulposus extrusion (HNPE) may occur in different stages, with varying amounts of hydrated nucleus pulposus and spinal cord compression.
- Surgical treatment may be indicated in compressive HNPE.

TREATMENT

Due to the degree of spinal cord compression and the heterogeneous appearance of the herniated material indicating at least partly firm disc material,¹¹ surgical treatment was recommended. The dog was placed in a sternal recumbency, and a right-sided hemilaminectomy (L2-3) using a dorsal approach was performed. Surgical findings confirmed the diagnosis of IVDE. A mixture of white gelatinous and partly firm material (cartilaginous appearance) was identified. All visible material was removed, and the cord appeared adequately decompressed along the length of the hemilaminectomy. Specimens for cytologic and histopathologic evaluation were collected. The wound was routinely closed, and a urinary catheter was placed.

OUTCOME AND FOLLOW-UP

The dog recovered well from surgery and was managed with fentanyl-ketamine-lidocaine CRI solution (2 ml/kg/day intravenous (IV)), fentanyl transdermal skin patch, gabapentin (10 mg/kg q8h orally), phenoxybenzamine (0.25 mg/kg q8h orally) and distigmine bromide (0.125 mg/kg q12h orally)

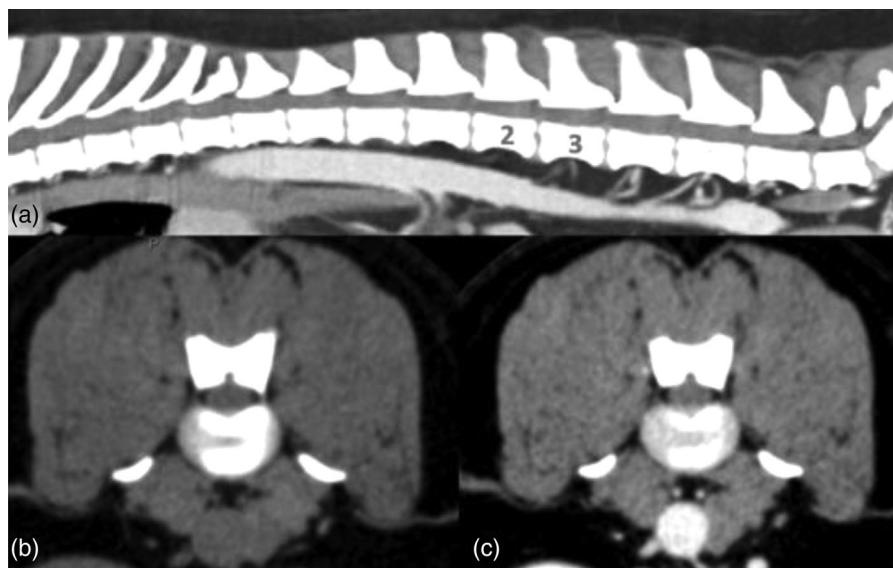


FIGURE 1 Midsagittal (a) and transverse (b) non-contrast enhanced and transverse (c) contrast-enhanced computed tomography image of a dog with a compressive hydrated nucleus pulposus extrusion (HNPE) at L2-3. Hypodense material with rim enhancement, consistent with HNPE, is not visible

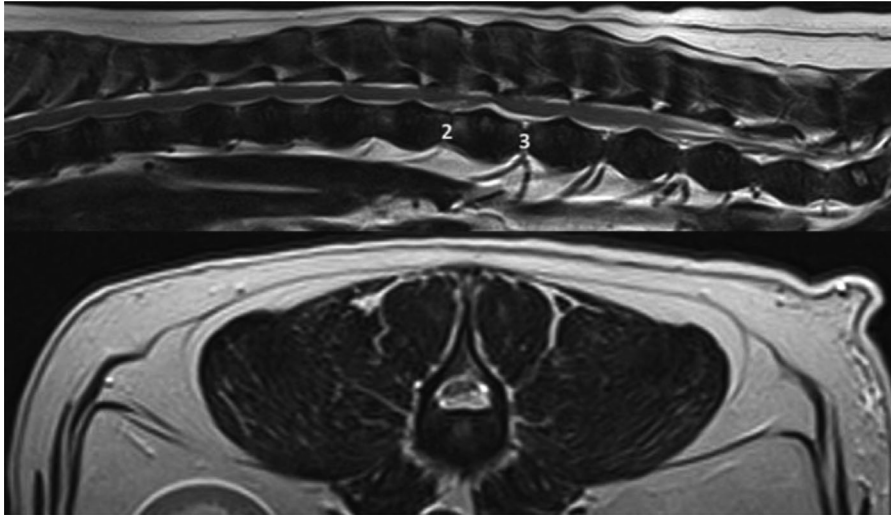


FIGURE 2 Midsagittal and transverse T2-weighted MRI image of a dog with a compressive hydrated nucleus pulposus extrusion (HNPE) at L2-3. There is a slightly right lateralised ventral extradural compression of hyperintense material mainly located over the intervertebral disc space

postoperatively. Physiotherapy (five-step protocol) was initiated the day after surgery. The urinary catheter was removed 2 days postoperatively, and the urinary bladder was manually expressed until voluntary urination was regained. The dog improved continuously neurologically, was able to walk and urinate voluntarily on day 5 postoperatively and was discharged the same day. Following interviewing the owner 2 months postoperatively and based on the owner's assessment, the dog no longer showed neurologic deficits and appeared comfortable. Return visits for additional testing were declined due to the remote location and the clinically normal status of the dog.

Cytological smears from extruded intervertebral disc material collected at surgery were stained with haematoxylin and eosin (H&E). The removed material was fixed in a solution of 10% neutral buffered formalin before being processed for paraffin embedding. H&E and Masson's trichrome stains were applied.

Cytopreparations presented an abundant background of basophilic matrix and lakes of eosinophilic amorphous acellular material, resembling chondroid matrix accompanied by numerous red blood cells. Multiple clusters of amorphous, basophilic chondroid material containing nucleated cells were also observed. These cells featured poorly defined margins, strong chromophilic and occasionally indented nuclei resembling chondrocytes/notochordal cells.

Histology revealed fragments of nucleus pulposus featuring irregularly shaped nests and islets containing two to four notochordal cells, embedded in the dense amorphous extracellular matrix, staining basophilic to slightly eosinophilic in H&E and diffusely blue on Masson's trichrome stains mounting up to 70%–75% of sections area. Multiple rows of linear and parallel oriented chondrocytes corresponding to the inner annulus fibrosus were also detected. Degenerative changes comprised nuclear pyknosis and necrosis of notochordal cells, as well as rare tears and clefts of the inner annulus fibrosus occasionally lined by fibrin. There was no evidence of inflammatory cells. These findings were consistent with the extrusion of the partially degenerated nucleus pulposus.

DISCUSSION

A dog with acute paraplegia was presented to a small animal hospital. According to the chondrodystrophic breed and neurological examination, IVDE as the most likely diagnosis was suspected. Radiographs and CT of the thoracolumbar spine were performed, but CT was unsuccessful in establishing a diagnosis.

One study supported the use of CT as a first-line imaging modality for dogs presenting with thoracolumbar myelopathy. Additional imaging was required in 17.4% of non-chondrodystrophic breeds but in only 3.6% of Dachshunds and in 13.6% after normal business hours.¹² However, CT is undertaken with the acceptance that further imaging might be required should no lesion be identified.¹³ Another study analysed the usefulness of CT for the assessment of HNPE. CT angiography revealed a lesion in all but one case with a sensitivity of 91% and specificity of 100% to differentiate between HNPE and Hansen type I IVDE.⁸ In the chondrodystrophic dog presented, HNPE was not detected on contrast-enhanced CT. CT-myelography was reported to have a higher diagnostic sensitivity, compared to non-contrast CT, CT angiography and myelography,¹⁵ but the risks associated with myelography are not avoided.¹³ In contrast, the probability of false-negative results is much lower, and sensitivity is approximately 10% higher with MRI, compared to non-contrast CT for the diagnosis of thoracolumbar IVDE.¹³ HNPE can affect small and large chondrodystrophic and non-chondrodystrophic dogs; it may also affect the thoracolumbar spine^{3–11} and should be considered a differential diagnosis that might not be detected on CT as demonstrated here. Furthermore, there are several different types of IVDE, IVDE including mineralisation visible on CT being only one of these types.² Considering the range of types of IVDE, the higher accuracy of MRI, compared to CT, the possibility of avoiding a second anaesthesia and additional costs for the owners, MRI may be more appropriate as the first-line imaging modality for thoracolumbar myelopathy even in chondrodystrophic dogs and out-of-hours. Future studies comparing CT angiography and MRI for the diagnosis of HNPE are required to confirm this assumption.

HNPE has a predilection for the cervical region.^{3–11} According to De Decker and Fenn¹⁶ and their experience, HNPE occurs in the thoracolumbar spine. This finding was recently supported by a study describing thoracolumbar HNPE in 21 dogs,¹⁴ and the case presented further adds information to a relatively small number of cases reported to date. Until 2022, no histological evidence supported HNPE in the canine thoracolumbar spine. A recent study reported histological support in one dog.¹⁴ Moreover, this case report further adds elaborate cytological and histological evidence for this condition.

Characteristic findings of HNPE^{4,6,7,9,16} and in part IVDE on MRI were detected in the dog presented, indicating a mixed pattern. This was also present in another case.¹⁶ Furthermore, there was an accentuation to one side, which is common in IVDE (Hansen type 1). This is supported by a recent study in which the extruded disc material of thoracolumbar HNPE was more commonly lateralised, compared to cervical HNPE.¹⁴ Cytological and histological examination of extradural material collected from dogs with HNPE consistently revealed a degree of partial nucleus pulposus degeneration.⁹ Another study found less amounts of degeneration of the extruded disc material of IVDE in the cervical spine, compared to the thoracolumbar spine.¹⁷ This is in accordance with this dog in which the herniated material was liquid and firm at surgery and consistent with partially degenerated nucleus pulposus on cytology and histology. HNPE may present with different stages of degeneration, especially in the thoracolumbar spine, and may be compressive. This may be in accordance with a recently published study in which dogs with thoracolumbar HNPE were more commonly treated surgically, compared to cervical HNPE due to the percentage of spinal cord compression detected on MRI.¹⁴ Studies encompassing larger numbers of cases, including histologic examination, are required to confirm this assumption.

HNPE is characterised by an acute extrusion of hydrated nucleus pulposus, resulting in varying degrees of spinal cord compression.¹⁶ The acute onset of severe clinical signs and reported rapid improvements with medical treatment could suggest that spinal cord contusion plays a major role in the pathophysiology of HNPE, questioning the value of surgical decompression.^{6,16} Medical management of HNPE in the cervical and thoracolumbar spine was proposed as a reasonable alternative to surgery due to the assumption of rapid resorption or dispersion of the extruded nucleus pulposus.^{10,11} However, different stages of degeneration in HNPE may exist. Depending on the degree of spinal cord compression and the consistency of herniated material seen in this dog, HNPE may be compressive, and absorption is unlikely. Therefore, HNPE may not be amenable to conservative therapy and requires surgical decompression, especially in the thoracolumbar spine of some dogs. This finding is, again, supported by a recent study in which 11 of 21 thoracolumbar cases were treated surgically according to spinal cord compression on MRI.¹⁴ A heterogeneous MRI appearance of the extruded material on T2w images additionally may serve as an orientation because it could indicate the presence of at least partly firm and less liquid disc material causing long-term compression without surgery.¹¹

The appropriate terminology of HNPE is controversial. Acute compressive HNPE was considered most appropriate.¹³ A liquid to gelatinous appearance may be compressive only

initially^{6,18} and more contusive in nature.¹⁰ Due to the histological findings, it has recently been suggested to refer to this condition as partially degenerated disk extrusions.⁹ According to the findings in this dog, this terminology might be more appropriate in general. However, HNPE may occur in different stages of degeneration and with varying degrees of spinal cord compression. In conclusion, compressive types of HNPE exist and may be appropriately termed compressive HNPE.

In summary, HNPE may present with different stages of degeneration, may be compressive and therefore requires surgical treatment in some dogs.

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CONFLICT OF INTEREST

The authors declare they have no conflict of interest.

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The authors received no specific funding for this work.

ETHICS STATEMENT

There is no ethical issue associated with this manuscript because the presented data were obtained during routine treatment in the dog. The dog was not involved in any kind of animal experiment. According to competent authorities, this kind of research does not require ethics approval or general approval with respect to German law.

AUTHOR CONTRIBUTIONS

Matthias Kornmayer planned and conducted this study. Sonja Fiedler and Marco Rosati contributed to cytology and histology. Andrea Meyer-Lindenberg reviewed the manuscript before submission.

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IMAGE QUIZ

Figure 2 shows midsagittal and transverse T2-weighted MRI images of an 8-year-old female neutered Maltese Bichon Frise weighing 11 kg with paraplegia of the hind legs. There is a slightly right lateralised ventral extradural compression of hyperintense and homo- to heterogeneous material located over the intervertebral disc space.

MULTIPLE CHOICE QUESTION

Based on the hyperintense and homo- to heterogeneous appearance of the compressive material, what is the likely diagnosis?

POSSIBLE ANSWERS TO MULTIPLE CHOICE QUESTION

- a) Intervertebral disc extrusion (IVDE)
- b) Intervertebral disc protrusion (IVDP)
- c) Acute non-compressive nucleus pulposus extrusion (ANNPE)
- d) Hydrated nucleus pulposus extrusion (HNPE)
- e) A combination of HNPE and IVDE
- f) Fibrocartilaginous embolic myelopathy (FCEM)

CORRECT ANSWER

The figures show a case of an intervertebral disc disease. The compressive material presents with characteristics of a hydrated nucleus pulposus extrusion (hyperintense material located over the intervertebral disc space) and IVDE (slight lateralisation, heterogeneous appearance), indicating an HNPE with a higher grade of degeneration and therefore representing a combination of HNPE and IVDE.