



Presumptive intramedullary intervertebral disc extrusion in 12 cats: clinical presentation, MRI findings, treatment and outcome

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Abstract

Objectives This study aimed to describe the clinical characteristics, MRI findings, treatment and outcome in cats presumptively diagnosed with intramedullary intervertebral disc extrusions.

Methods A retrospective review was conducted of medical records and MRI data from cats presumptively diagnosed with intramedullary intervertebral disc extrusions. Long-term outcome (≥ 6 months) was assessed through medical records, questionnaires completed by the owners or both.

Results A total of 12 cats met the inclusion criteria. All presented with peracute or acute clinical signs, with nine having confirmed ($n = 3$) or possible ($n = 6$) external trauma based on history, physical examination or MRI findings. Seven cats were ambulatory and five were non-ambulatory. Eight cats presented with urinary incontinence; none exhibited faecal incontinence. Neuroanatomical localisation included the T3–L3 ($n = 7$) and L4–S3 ($n = 5$) spinal cord segments. MRI showed an intramedullary intervertebral disc extrusion at the following sites: T12–T13 ($n = 1$), T13–L1 ($n = 1$), L1–L2 ($n = 2$), L2–L3 ($n = 2$), L4–L5 ($n = 3$) and L5–L6 ($n = 3$). All cats underwent treatment and were discharged after a median hospitalisation time of 4 days (range 3–14). All non-ambulatory cats with available follow-up information (4/5) regained ambulation by the time of the short-term (< 6 weeks) or long-term (≥ 6 months) assessment. Moreover, all cats either retained or regained urinary continence by the time of discharge, the short-term (< 6 weeks) or the long-term (≥ 6 months) assessment. Overall, nine cats achieved a successful outcome and

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were considered functional pets at the short-term (<6 weeks) and/or long-term (≥ 6 months) follow-up. Two cats were lost to follow-up, and one cat had perceived persistent generalised discomfort.

Conclusions and relevance Most cats presumptively diagnosed with an intramedullary intervertebral disc extrusion showed a favourable outcome with treatment in this study. This condition should be considered in cats presenting with peracute or acute signs of T3–L3 or L4–S3 spinal cord dysfunction, especially if there is a history or indication of trauma.

Keywords: Intramedullary intervertebral disc extrusion; intervertebral disc disease; MRI; non-compressive nucleus pulposus extrusion

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Introduction

Intramedullary intervertebral disc extrusions (IIVDEs) are a rare type of intervertebral disc herniation, wherein the nucleus pulposus of an intervertebral disc extrudes into an intramedullary location.¹ This condition has been predominantly characterised in dogs, whereby affected dogs typically present with peracute or acute neurological signs, often after physical activity or trauma.² To date, feline IIVDEs have been documented in only a few cases: three case reports and a brief mention of four cases in a study on feline intervertebral disc herniations.^{3–6} As in dogs, these cats exhibited peracute or acute onset of neurological signs, although preceding trauma was reported in only one instance.³ Feline acute non-compressive nucleus pulposus extrusions (ANNPEs), another form of peracute non-compressive intervertebral disc extrusion, and feline ischaemic myelopathies (FIMs) are also characterised by peracute or acute neurological signs and can follow trauma.^{1,7–9}

A definitive diagnosis of IIVDE is established histopathologically, after surgical retrieval of the intramedullary material or necropsy.^{1,5,6} MRI is the primary imaging modality for making a presumptive diagnosis, although CT and radiography have also been reported.^{1–3}

Surgical and non-surgical treatments have been employed for canine and feline cases of IIVDE. Non-surgical management usually involves rest, analgesia and physiotherapy.^{1,2,4,5} Surgery aims to remove the intramedullary material.^{5,6} There is currently insufficient information in the literature to provide therapeutic recommendations for canine and feline IIVDE.

Given the scarce literature on feline IIVDE, little is known about the clinical presentation, imaging findings, treatment and outcome in affected cats. The aim of this study was to describe the clinical features, MRI findings, treatment and outcome in a larger case series of cats presumptively diagnosed with IIVDE based on MRI. We hypothesised that cats with IIVDE would exhibit a presentation similar to canine IIVDE, feline ANNPE and FIM cases, with an overall favourable outcome.¹

Materials and methods

Ethical approval

The study was approved by the Royal College of Veterinary Surgeons (RCVS) Ethics Review Panel (reference number 2024-048).

Inclusion criteria

The clinical databases of seven referral centres (Willows Veterinary Centre & Referral Service, Dick White Referrals, Dovecote Veterinary Hospital, ChesterGates Veterinary Specialists, Veterinary Specialists Scotland, the University of Guelph and the University of Turin) were searched for cats presumptively diagnosed with IIVDE after MRI. The period searched varied between 2009 and 2024, depending on the availability of a neurology service and MRI at each institution. To be included, cats were required to have a presumptive diagnosis of IIVDE based on MRI. Collected data included signalment, preceding history, time to presentation at the referral hospital, pre-referral treatment, physical and neurological examination findings, MRI findings suggestive of IIVDE and other abnormalities, post-diagnosis treatment, duration of hospitalisation and complications.

MRI

MRI was performed using either a 0.25 T, 0.4 T or 1.5 T scanner, depending on the institution: a 1.5 T scanner (Magnetom Sola; Siemens Healthcare Limited, or Signa HD; GE Healthcare) at Willows Veterinary Centre & Referral Service, a 0.4 T scanner (Hitachi Aperto Lucent; Hitachi Medical Systems) or 1.5 T scanner (Signa Voyager AIR Edition; GE Healthcare) at Dick White Referrals, a 0.25 T scanner (Esaote; VetMR) at Dovecote Veterinary Hospital, a 1.5 T scanner (Magnetom Sola; Siemens Healthcare Limited) at ChesterGates Veterinary Specialists, a 1.5 T scanner (GE Signa Excite HDxt; GE Healthcare) at Veterinary Specialists Scotland, a 1.5 T scanner (Signa Excite II; General Electric Medical Systems) at the University of Guelph and a 0.25 T scanner (Grande Esaote; VetMR) at the University of Turin.

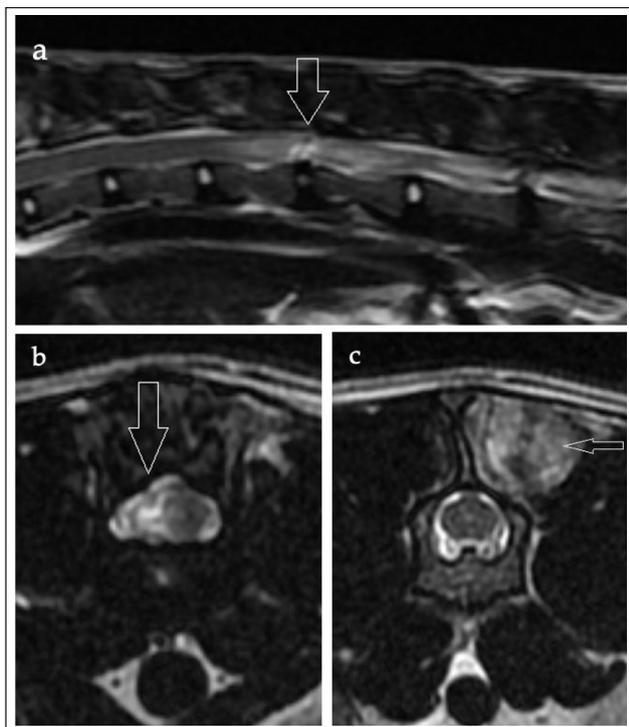


Figure 1 (a) Sagittal T2-weighted image of the thoracolumbar vertebral column, (b) transverse T2-weighted image at the level of the T13–L1 intervertebral disc space, and (c) transverse T2-weighted image at the level of the L2 vertebral body of a domestic shorthair cat aged 3 years 5 months. (a) A linear hypointense tract extends from the T13–L1 intervertebral disc into the spinal cord parenchyma, surrounded by an ill-defined hyperintense area (arrow). The T13–L1 nucleus pulposus shows a reduced volume compared with the adjacent discs. (b) Right-sided intramedullary changes are evident at the level of the T13–L1 intervertebral disc (arrow), with no apparent extraneous material in the epidural space. (c) A relatively well-demarcated hyperintensity within the epaxial musculature at the level of the L2 vertebral body, suggestive of epaxial muscle contusion or oedema (not haemorrhage, based on excluded T2*-weighted gradient-recall echo images), was considered potentially indicative of external trauma or secondary to the extrusion (arrow)

T2-weighted sagittal and transverse images were obtained for all cats. Each MRI study was reviewed by a board-certified radiologist (ED) to validate the presumptive IIVDE diagnosis. ED was not involved in the clinical database search and was blinded to the clinical presentation and neurolocalisation. Only cases with MRI findings consistent with IIVDE were included in the study. These included the following: (1) a reduction in the volume of the T2-weighted hyperintense signal of the nucleus pulposus; (2) narrowing of the intervertebral disc; (3) a focal intramedullary T2-weighted hyperintense lesion overlying the affected intervertebral disc; (4) focal spinal

cord swelling dorsal to the affected intervertebral disc; and (5) a tract extending from the intervertebral disc dorsally into the spinal cord (Figure 1). To differentiate cats with presumptive ANNPE based on the inclusion criteria in Taylor-Brown and De Decker,⁷ cats with evidence of extradural material or signal change within the epidural space were excluded. MRI studies of insufficient quality to reliably assess the epidural space were therefore excluded. Two cases were excluded because of insufficient MRI sequence quality.

Follow-up

Short-term follow-up was defined as up to 6 weeks after discharge, with data collected from medical records. Long-term follow-up required a minimum period of 6 months and was gathered through questionnaires completed by the cats' owners and medical records from the referring veterinary surgeons (RVSs), where available. In accordance with the RCVS Ethics Review Panel, only owners of cats that were alive at the time of data collection were contacted. Owners received a document detailing the study, along with a standardised questionnaire that had been approved by the RCVS Ethics Review Panel. The questionnaire included questions on specific aspects of the cat's condition, such as demeanour, comfort, ambulatory status, continence and perceived quality of life (see the questionnaire in the supplementary material). The outcome was considered successful if the cat was a functional pet (independently ambulatory, urinary and faecally continent, and considered pain-free with a good quality of life) and was considered unsuccessful if the cat had not become a functional pet by the long-term follow-up.

Results

Signalment

A total of 12 cats were included in the study (Table 1). The cats had a median age of 8 years (range 3 years 4 months to 12 years 3 months) at presentation. Three cats were castrated males and nine were spayed females. Breeds included domestic shorthair (n=9) and domestic longhair (n=3).

Historical findings

All cats exhibited a peracute (immediate) or acute (<24h) onset of signs. The median time to presentation at the referral hospital was 48h (range 0–168) after the onset of neurological signs. Before presentation, three cats had experienced trauma that was witnessed (fall from a height [n=2] and collision with a wall [n=1]). The clinical signs were non-progressive in all cats. Eight cats had spinal hyperaesthesia reported by the RVS; 11 cats received various combinations of drugs with analgesic properties before referral, including meloxicam (n=8), methadone

Table 1 Signalment, clinical presentation and outcome of 12 cats presumptively diagnosed with intramedullary intervertebral disc extrusion (IIVDE)

Cat	Age	Sex	Breed	Neurological examination findings at presentation	Neurolocalisation	Site of IIVDE	MRI field	Was trauma suspected?	Initial urinary status	Time in hospital (days)	Neurological status changes and urinary status at discharge	Short-term follow-up	Long-term follow-up	Outcome
1	11 y 2 m	MN	DSH	Ambulatory paraparetic; bilateral plantigrade stance; decreased withdrawal reflex in right pelvic limb, decreased perineal reflexes	L4–S3, right lateralisation	L5–L6	High	Yes (based on imaging)	Normal	1	Static; normal urination	Neurologically normal; normal urination (3 weeks after discharge)	NA	Successful
2	5 y	MN	DSH	Non-ambulatory paraparetic on left pelvic limb and plegic right pelvic limb; normal nociception	T3–L3, right lateralisation	L2–L3	High	Yes (based on imaging)	Incontinent; IUC placed	5	Mild improvement; non-ambulatory paraparetic with good movement noted bilaterally; normal urination	NA	Ambulatory paraparetic and impaired (albeit improved) ability to jump and climb; normal urination (28 m after discharge)	Successful
3	8 y 3 m	FN	DLH	Ambulatory paraparetic; bilateral plantigrade stance; decreased withdrawal reflex in left pelvic limb	L4–S3, left lateralisation	L5–L6	High	No	Incontinent; IUC placed	6	Mild improvement; normal withdrawal reflexes; normal urination	Neurologically normal (6 weeks after discharge)	Neurologically normal (46 m after discharge)	Successful
4	3 y 5 m	MN	DSH	Ambulatory monoparetic in right pelvic limb; normal spinal reflexes	T3–L3, right lateralisation	T13–L1	High	Yes (superficial skin wounds)	Incontinent; MBE required	1	Static; MBE required	NA	Ambulatory (improved) and impaired (albeit improved) normal urination (84 m after discharge)	Successful
5	7 y	FN	DSH	Ambulatory paraparetic; postural reactions absent in right pelvic limb and delayed in left pelvic limb	T3–L3, right lateralisation	T12–T13	High	Yes (based on imaging)	Incontinent; MBE required	3	Mild improvement; delayed postural reactions in pelvic limbs; MBE required	Ambulatory; normal urination (6 weeks after discharge)	Normal ambulation but impaired (albeit improved) normal urination (63m post-discharge)	Successful
6	8 y	FN	DSH	Ambulatory paraparetic	T3–L3, no lateralisation	L4–L5	Low	Yes (superficial skin wounds)	Incontinent; MBE required	4	Mild improvement; normal urination	Ambulatory paraparetic; normal urination (4 weeks after discharge)	Abnormal (static) demeanour and comfort. Ambulatory (improved). Abnormal (worsened) ability to jump and climb. Normal urination (98 m after discharge)	Unsuccessful
7	5 y	FN	DLH	Paraplegic with normal nociception	T3–L3, no lateralisation	L1–L2	Low	Yes (witnessed)	Incontinent; MBE required	3	Static; MBE required	NA	Ambulatory paraparetic and impaired (albeit improved) normal urination (40 m after discharge)	Successful

(Continued)

Table 1 (Continued)

Cat	Age	Sex	Breed	Neurological examination findings at presentation	Neurolocalisation	Site of IIVDE	MRI field	Was trauma suspected?	Initial urinary status	Time in hospital (days)	Neurological status changes and urinary status at discharge	Short-term follow-up	Long-term follow-up	Outcome
8	4 y 1 m	FN	DLH	Ambulatory paraparetic; bilateral plantigrade stance; postural reactions absent in left pelvic limb and delayed in right pelvic limb	L4-S3, left lateralisation	L4-L5	High	Yes (witnessed)	Incontinent; MBE required	7	Mild improvement; delayed postural reactions in pelvic limbs; normal urination	Ambulatory paraparetic; normal urination (2 weeks after discharge)	Neurologically normal (90 m after discharge)	Successful
9	8 y	FN	DSH	Non-ambulatory paraparetic; decreased patellar and withdrawal reflexes in left pelvic limb	L4-S3, left lateralisation	L4-L5	High	No	Incontinent; MBE required	2	Static; normal urination	NA	NA	LTF
10	8 y	FN	DSH	Non-ambulatory paraparetic; delayed pelvic limb postural reactions; worse on the right	T3-L3, right lateralisation	L2-L3	Low	Yes (superficial skin wounds)	Normal	3	Static; normal urination	Ambulatory paraparetic; normal urination (4 weeks after discharge)	Ambulatory paraparetic and impaired (albeit improved) ability to jump and climb; normal urination (14 m after discharge)	Successful
11	8 y 8 m	FN	DSH	Ambulatory paraparetic; worse on left; bilateral plantigrade stance	L4-S3, left lateralisation	L5-L6	Low	No	Normal	14	Static; normal urination	NA	NA	LTF
12	12 y 3 m	FN	DSH	Non-ambulatory paraparetic; absent postural reactions in left pelvic limb; markedly decreased postural reactions in right pelvic limb	T3-L3, left lateralisation	L1-L2	Low	Yes (witnessed)	Normal	3	Static; normal urination	Ambulatory paraparetic (4 weeks after discharge)	NA	Successful

DLH = domestic longhair; DSH = domestic shorthair; FN = female neutered; IIVDE = intramedullary intervertebral disc extrusion; IUC = indwelling urinary catheter; LTF = lost to follow-up; m = months; MN = male neutered; MBE = manual bladder expression; NA = not available; y = years

(n=4), buprenorphine (n=4), gabapentin (n=1) and diazepam (n=1).

Clinical signs on referral

Three cats showed signs consistent with external trauma (scuffed nails and superficial skin wounds), without a witnessed traumatic event. All cats exhibited signs associated with paraparesis or paraplegia; nociception was present in all cats (Table 1). Spinal hyperaesthesia was detected in six cats over the region of the subsequently diagnosed IIVDE. Neuroanatomical localisation included the T3–L3 (n=7) and L4–S3 (n=5) spinal cord segments. Eight cats presented with urinary incontinence and none exhibited faecal incontinence.

MRI findings

MRI revealed abnormalities consistent with IIVDEs at T12–T13 (n=1), T13–L1 (n=1), L1–L2 (n=2), L2–L3 (n=2), L4–L5 (n=3) and L5–L6 (n=3). Cats 1, 2 and 5 had imaging findings potentially suggestive of trauma, without a witnessed traumatic event or external signs of trauma (Table 1). Cat 1 had a right-sided L5–L6 IIVDE with an associated ill-defined T2-weighted hyperintensity primarily located within the left iliopsoas muscle at the L5 vertebra, with mild contrast enhancement. Cat 2 had an L2–L3 IIVDE identified along with a fracture of the left transverse process of L6, two minimally to non-compressive partially hydrated intervertebral disc extrusions at L3–L4 and L4–L5, and ill-defined T2-weighted and Dixon (fat saturation) hyperintensities within the right thoracoabdominal wall. Cat 5 had a right-sided T12–T13 IIVDE, along with ill-defined T2-weighted and Short Tau Inversion Recovery (STIR) hyperintensities in the left epaxial muscles extending from L1 to L3, which showed contrast enhancement. Including cats 1, 2 and 5, a total of nine cats had been involved in a possible or witnessed traumatic event.

Treatment and short-term outcome

All cats received non-surgical management. Four cats received physiotherapy given by registered veterinary nurses or physiotherapists while hospitalised, including massage, passive range of motion, assisted standing and laser therapy. Eight cats received analgesia after diagnosis, which included a combination of meloxicam (n=6), gabapentin (n=2) and opioids (buprenorphine [n=1] and tramadol [n=1]). The prescribed duration of analgesia was in the range of 5–14 days. Short-term follow-up was available for seven cats and was in the range of 2–6 weeks (Table 1). All cats appeared comfortable without analgesia during their follow-up examination, but the owners of cat 6 reported an abnormal long-term level of comfort, which had been static since discharge but was not deemed to warrant long-term analgesia (Table 1).

Eight cats (three non-ambulatory and five ambulatory) required bladder management during hospitalisation via an indwelling urinary catheter (IUC) (n=2) or manual expression (n=6) (Table 1). Two cats with an IUC also received medical therapy to enable bladder expression: cat 2 received prazosin (1 mg PO q8h for 7 days) and cat 3 received diazepam (0.2 mg/kg IV q8h during hospitalisation). Cat 8 developed a urinary tract infection despite manual expression and was medicated with amoxicillin-clavulanic acid (12.5 mg/kg PO q12h) before discharge. Of the eight cats, five regained normal urination by discharge (within 2–7 days) (Table 1). The three remaining cats required bladder expression at discharge (hospitalisation time 1–3 days). All cats eventually regained normal urination (Table 1).

The median duration of hospitalisation was 4 days (range 1–14). No complications were observed during hospitalisation other than the urinary tract infection in cat 8. All cats had a static ambulatory status at discharge compared with presentation (Table 1). However, cat 2 had mildly improved, becoming non-ambulatory paraparetic with good movement in both pelvic limbs, compared with its presentation of non-ambulatory paresis in the left pelvic limb and plegia in the right pelvic limb. Five cats also showed mild improvements in their neurological examinations by the time of discharge. No cat had deteriorated. Both cat 9 (non-ambulatory at presentation) and cat 11 (ambulatory at presentation) were lost to follow-up, with static examinations at discharge (Table 1). The duration of hospitalisation for each case is shown in Table 1.

All cats were ambulatory by their short-term follow-up, with a normal gait (n=3) or paraparesis (n=4) (Table 1). Compared with presentation, all cats had an improved neurological examination. Cat 12 was reported to be neurologically normal by its owner 2 months after discharge.

Long-term outcome

Long-term follow-up was obtained for eight cats, either through an owner questionnaire alone (n=4) or through information from both the RVS and an owner questionnaire (n=4). Long-term outcome data were collected 14–98 months (median 54) after discharge (Table 1). Cats 3 and 8 were reportedly neurologically normal. The remaining six cats were ambulatory, albeit with an abnormal gait that had improved since discharge (n=5). All cats, other than cat 6, had an improved (although still abnormal) ability to jump and climb (Table 1).

Four cats had environmental modifications after the IIVDE diagnosis: all had restricted outdoor access and cat 7 required a shallow litter tray to accommodate access.

Most owners (7/8) reported that the IIVDE had not affected their cat's quality of life. The owner of cat 6 felt its quality of life had been 'mildly affected' because of perceived persistent generalised discomfort not focally

associated with the L4–L5 IIVDE, abnormal demeanour and paraparesis (Table 1).

In this study, 9/12 (75%) cats had a successful outcome and were considered functional pets at the time of either the short-term or the long-term follow-up (Table 1). Two cats were lost to follow-up (cats 9 and 11): cat 9 remained non-ambulatory at the time of discharge, while cat 11 was ambulatory, with normal urination. When considering only the cats with follow-up information, 9/10 (90%) cats achieved a successful outcome in this study. A successful outcome did not seem to be obviously correlated to neurological status at presentation.

Discussion

To the authors' knowledge, this is the largest case series on feline IIVDE to date. IIVDEs are a rare form of intervertebral disc herniation,¹ as indicated by the identification of only 12 cases across seven referral centres between 2009 and 2024. Based on the findings of this study, feline patients with IIVDE appear to have a characteristic presentation, akin to canine IIVDE, feline ANNPE and FIM, generally with a positive outcome.¹

In this study, 9/12 cats diagnosed with IIVDE had clinical histories, physical examination findings or MRI results indicative of a preceding traumatic event. Notwithstanding this, T2 and STIR hyperintensities in the paraspinal muscles, occasionally accompanied by enhancement, have been reported in dogs with compressive intervertebral disc extrusions and ANNPEs, and are associated with histopathological evidence of degenerative and inflammatory processes. Thus, the muscle changes observed in cats 1 and 5 in the present study may similarly reflect these processes rather than trauma.^{10–12} Similar muscle changes have been reported in feline ANNPEs; however, to the authors' knowledge, these have not been reported in FIM cases.^{7,9}

The literature on feline IIVDE contains only one case report that attributes a traumatic cause, where the cat had fallen from a roof.³ In dogs, IIVDEs often arise secondary to trauma or exercise.^{2,13} Notably, none of the cats in this study, nor in the previously published literature on IIVDE to the authors' knowledge, had undergone exercise before the onset of clinical signs. In contrast, FIM cases have been reported with both traumatic and exercise-induced triggers.⁹ Taylor-Brown and De Decker⁷ and Bibbiani et al⁸ documented 8/11 and 4/22 cases of feline ANNPE, respectively, in which a traumatic event was either witnessed or suspected. Bibbiani et al⁸ also noted that vigorous exercise preceded feline ANNPE in 9/22 cases. IIVDEs are thought to share a similar pathophysiology with ANNPEs, where excessive force on intervertebral discs results in a high-velocity extrusion of a fragment of non-degenerated nucleus pulposus into the vertebral canal.¹ Thus, it is not unexpected that trauma is a triggering factor for these cases.

All cats in this study presented with peracute or acute non-progressive neurological signs, which aligns with other cases of feline^{3–5} and canine² IIVDE. Cats with ANNPEs and ischaemic myelopathies (IMs) also typically present with peracute to acute non-progressive neurological signs.^{7–9} Vocalisation at the onset of neurological dysfunction has been reported in two case reports of dogs with IIVDEs;^{13,14} however, vocalisation was not observed in this study or previous feline IIVDE, feline ANNPE and FIM literature.^{1,9} In this study, 8/12 cats exhibited later-alisation of signs, a phenomenon previously observed in cats and dogs with IIVDEs, ANNPEs and IMS.^{1–5,9}

IIVDEs were more frequently located in the lumbar spinal cord, most commonly at L4–L5 and L5–L6 in this study. Previous reports of feline IIVDE also found a lumbar location to be overrepresented: in total, the seven previously reported sites of feline IIVDE were L3–L4 (n=1), L4–L5 (n=3) and L5–L6 (n=3).^{3–6} In canine cases, IIVDEs typically present in two spinal cord locations: cervical or thoracolumbar (between T11 and L4).² To the authors' knowledge, no feline cases of a cervical IIVDE have been reported. In contrast, feline ANNPEs and FIMs have been reported in cervical and thoracolumbar locations.^{7–9,15,16}

All cats in this study received non-surgical treatment and by discharge all showed improvement in their neurological status or remained static. The noted improvements were often subtle, with the most significant being cat 2, which regained voluntary movement before discharge. Although none of the non-ambulatory cats in this study regained ambulation during hospitalisation, at least 4/5 eventually regained ambulation (one cat was lost to follow-up). This outcome suggests a more favourable prognosis than previous publications, wherein only 1/3 IIVDE cats managed non-surgically regained ambulation.⁶

Only four cats in this study were deemed neurologically normal at their short- or long-term follow-up assessments; however, all ambulatory cats with follow-up data (6/7) remained ambulatory. In 7/8 cats, quality of life was reportedly unaffected after their IIVDE diagnosis. Of these, 2/8 were reported to be neurologically normal. This conclusion parallels feline ANNPE and FIM, where the overall outcome is considered favourable for these cases, although long-term neurological deficits are to be expected.^{1,7,9}

Only two cats are reported to have undergone surgical treatment for IIVDEs in the literature. Both cats showed improvement in neurological signs during hospitalisation; however, neither cat was considered neurologically normal: one cat remained mildly paraparetic, while the other was lost to follow-up.^{5,6} Currently, there is insufficient information in the literature to provide recommendations for the treatment of cats with IIVDEs. Future prospective studies with larger case numbers investigating risk factors for poor outcomes would be beneficial in guiding the decision-making process regarding

IIVDE management. Although larger studies permitting multivariate analyses would be valuable, IIVDEs are rare diagnoses, making it challenging to obtain sufficient case numbers.

Urinary incontinence and subsequent bladder management are significant considerations in cats diagnosed with IIVDEs compared with dogs. In a study on 20 canine cases of IIVDEs, only two displayed urinary incontinence, and both were paraplegic without nociception at presentation.² In contrast, the present study found that 8/12 cats required bladder management due to urinary incontinence, regardless of their neurological status. This finding aligns with previous reports, in which 3/7 cats with IIVDEs also exhibited urinary incontinence; notably, all three of those cases also had faecal incontinence,^{3,5,6} unlike in this study. In the present study, all eight cats regained normal bladder control either by discharge or by short- or long-term follow-up. Overall, the outcome for urinary incontinence in cats is comparable to that of feline ANNPEs, in which only 1/5 affected cats required long-term bladder management.⁷ In contrast, FIM cases tend to have better bladder control, with only 2/19 cats in one study requiring in-hospital management; both cases had normal urination by discharge.⁹

Limitations

The retrospective design may have introduced biases in data collection and variability in the evaluation of objective clinical measures. Further limitations are the small sample size and lack of any histopathological diagnosis. Cases in this study were selected on MRI findings, following our stated imaging inclusion criteria, which were adapted from previously documented cases of canine and feline IIVDEs. Although histopathological confirmation remains the definitive method for diagnosing IIVDEs, no cat in this case series underwent surgical retrieval of intramedullary material and no cats underwent post-mortem examination. As such, our diagnoses are based on a combination of MRI characteristics and clinical context, and are referred to as presumptive IIVDEs. This reflects both the diagnostic uncertainty and the pragmatic limitations of confirming this condition in living animals with positive clinical trajectories.

In addition, not all outcome variables were available for every cat, and missing data may have influenced our results. Furthermore, the study population comprised only referral hospital caseloads, which could introduce bias towards more severe phenotypes and owners with fewer financial constraints compared with the general population. Although larger studies that allow for multivariate analyses would be beneficial, the rarity of IIVDEs would make it challenging to obtain sufficient case numbers.

A further limitation is that long-term outcome data were obtained in part through standardised owner

questionnaires, which may introduce subjectivity and reporting bias. Although we did not rely on owners to assess specific neurological deficits, their observations provided insight into functional outcomes such as ambulation, continence, comfort and overall quality of life. These metrics, although not as precise as formal veterinary assessments, remain valuable from a clinical perspective, particularly when assessing long-term management success in companion animals. Nonetheless, we acknowledge that this approach lacks the diagnostic rigour of repeat neurological examinations conducted by qualified clinicians.

Conclusions

Cats with IIVDEs typically present with peracute to acute clinical signs, often after a traumatic event. As with other thoracolumbar myelopathies, urinary incontinence is a common comorbidity, regardless of the cat's ambulatory status, highlighting the importance of appropriate bladder management. IIVDEs in cats appear to occur exclusively within the thoracolumbar spinal cord, with the L4–L5 and L5–L6 intervertebral disc spaces most commonly affected. Non-surgical management of this condition generally results in a favourable outcome, with most cases showing neurological improvement sufficient to maintain an acceptable quality of life (ie, remaining or becoming ambulatory, continent and comfortable).

Supplementary material The following file is available as supplementary material:

Feline intramedullary intervertebral disc extrusion questionnaire for owners.

Conflict of interest TH, LDR, ES, AF and LS are employees of Linnaeus Veterinary Limited, which is part of Mars Veterinary Health, a provider of veterinary services. ED and EA are employees of AniCura, which is part of Mars Veterinary Health, a provider of veterinary services. TM and SS are employees of CVS Group (UK) Limited, a provider of veterinary services.

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Ethical approval The work described in this manuscript involved the use of non-experimental (owned or unowned) animals. Established internationally recognized high standards ('best practice') of veterinary clinical care for the individual patient were always followed and/or this work involved the use of cadavers. Ethical approval from a committee was therefore not specifically required for publication in *JFMS*. Although not required, where ethical approval was still obtained, it is stated in the manuscript.

Informed consent Informed consent (verbal or written) was obtained from the owner or legal custodian of all animal(s) described in this work (experimental or non-experimental

animals, including cadavers, tissues and samples) for all procedure(s) undertaken (prospective or retrospective studies). For any animals or people individually identifiable within this publication, informed consent (verbal or written) for their use in the publication was obtained from the people involved.

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References

- 1 De Risio L. **A review of fibrocartilaginous embolic myelopathy and different types of peracute non-compressive intervertebral disk extrusions in dogs and cats.** *Front Vet Sci* 2015; 2: 24. DOI: 10.3389/fvets.2015.00024.
- 2 Kim J, Kim H, Hwang J, et al. **Preliminary study of presumptive intradural-intramedullary intervertebral disc extrusion in 20 dogs.** *J Vet Sci* 2020; 21: e52. DOI: 10.4142/jvs.2020.21.e52.
- 3 McConnell JF and Garosi LS. **Intramedullary intervertebral disk extrusion in a cat.** *Vet Radiol Ultrasound* 2004; 45: 327–330.
- 4 Hammond LJ and Hecht S. **Susceptibility artifacts on T2*-weighted magnetic resonance imaging of the canine and feline spine.** *Vet Radiol Ultrasound* 2015; 56: 398–406.
- 5 Debreuque M, Valin I, Prata D, et al. **Case report: intramedullary intervertebral disk extrusion in a cat: clinical, computed tomographic, high-field magnetic resonance imaging, and outcome findings.** *Front Vet Sci* 2020; 7. DOI: 10.3389/fvets.2020.583892.
- 6 Amey JA, Liatis T, Cherubini GB, et al. **Outcomes of surgically and conservatively managed thoracolumbar and lumbosacral intervertebral disc herniations in cats.** *J Vet Intern Med* 2024; 38: 247–257.
- 7 Taylor-Brown FE and De Decker S. **Presumptive acute non-compressive nucleus pulposus extrusion in 11 cats: clinical features, diagnostic imaging findings, treatment and outcome.** *J Feline Med Surg* 2017; 19: 21–26.
- 8 Bibbiani L, Gelendi S, Bernardini M, et al. **Prevalence, clinical presentation and MRI of intervertebral disc herniations in cats.** *J Feline Med Surg* 2022; 24: e443–e452.
- 9 Theobald A, Volk HA, Dennis R, et al. **Clinical outcome in 19 cats with clinical and magnetic resonance imaging diagnosis of ischaemic myelopathy (2000–2011).** *J Feline Med Surg* 2013; 15: 132–141.
- 10 Trampus P, Goepfert C, Welle M, et al. **Magnetic resonance imaging signal alterations in paraspinal muscles in dogs with acute thoracolumbar intervertebral disk extrusion.** *Front Vet Sci* 2018; 5: 16. DOI: 10.3389/fvets.2018.00016.
- 11 Furtado ARR, Cherubini GB and Taeymans O. **Low-field magnetic resonance changes in the paravertebral musculature of dogs with acute intervertebral disc extrusion.** *J Small Anim Pract* 2019; 60: 367–373.
- 12 Morrison EJ, Baron-Chapman ML and Chalkley M. **MRI T2/STIR epaxial muscle hyperintensity in some dogs with intervertebral disc extrusion corresponds to histologic patterns of muscle degeneration and inflammation.** *Vet Radiol Ultrasound* 2021; 62: 150–160.
- 13 Lin M, Kent M, Glass EN, et al. **Pathology in practice.** *J Am Vet Med Assoc* 2022; 259: 53–56.
- 14 Kent M, Holmes S, Cohen E, et al. **Imaging diagnosis—CT myelography in a dog with intramedullary intervertebral disc herniation.** *Vet Radiol Ultrasound* 2011; 52: 185–187.
- 15 Lu D, Lamb CR, Wesselingh K, et al. **Acute intervertebral disc extrusion in a cat: clinical and MRI findings.** *J Feline Med Surg* 2002; 4: 65–68.
- 16 Chow K, Beatty JA, Voss K, et al. **Probable lumbar acute non-compressive nucleus pulposus extrusion in a cat with acute onset paraparesis.** *J Feline Med Surg* 2012; 14: 764–767.