Prevalence and breed predisposition for thoracolumbar intervertebral disc disease in cats

Steven De Decker, Anne-Sophie Warner, Holger A Volk.

Clinical Science and Services, The Royal Veterinary College, University of London, Hatfield, UK

Corresponding author: Steven De Decker, DVM, PhD, DipECVN, MvetMed, FHEA, MRCVS

Email: sdedecker@rvc.ac.uk

Address: Clinical Science and Services, The Royal Veterinary College, University of London, Hawkshead Lane, North Mymms, Hatfield, Hertfordshire, AL9 7TA, UK

Tel: +44(0)1707 666366

Fax: +44 (0)1707 649384

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Abstract

Objectives: to evaluate the prevalence and possible breed predilections for thoracolumbar intervertebral disc disease (IVDD) in cats.

Methods: Medical records and imaging studies of cats diagnosed with thoracolumbar IVDD were retrospectively reviewed and compared to the general hospital population between January 2008 and August 2014. The association between type of IVDD [i.e. intervertebral disc extrusion (IVDE) or intervertebral disc protrusion (IVDP)] and breed, age, gender, duration and severity of clinical signs was also evaluated.

Results: Of 12900 cats presented during the study period, 31 (0.24%) were diagnosed with IVDD, including 17 purebred and 14 non-purebred cats. Of all presented purebred cats, 0.52% were diagnosed with thoracolumbar IVDD. More specifically, 1.29% of all British Shorthairs and 1.83% of all presented Persians were diagnosed with IVDD. Compared to the general hospital population, purebred cats (P=0.0001), British Shorthairs (P<0.0001) and Persians (P=0.0006) were significantly overrepresented with thoracolumbar IVDD. Affected purebred cats were younger compared to affected non-purebred cats (P=0.02). Of 31 cats with IVDD, 19 were diagnosed with IVDE and 12 with IVDP. Cats with IVDE had a significantly shorter duration of clinical signs (P=0.0002) and demonstrated more severe neurological deficits (P=0.04) compared to cats with IVDP.

Conclusions and relevance: Although thoracolumbar IVDD is an uncommon condition in cats, purebred cats, British Shorthairs, and Persians were overrepresented. It is currently unclear if this represents a true breed predisposition or a higher likelihood of owners of purebred cats to seek referral for advanced diagnostic imaging procedures.

Introduction

Although our knowledge of feline spinal cord diseases has increased continuously over years, the diagnosis and treatment of the most common spinal disease processes, such as feline infectious peritonitis and lymphoma, remain challenging[1,2], while less common feline spinal disorders still need to be better characterised. A previous study, evaluating the prevalence of histologically confirmed spinal disorders in cats, demonstrated that inflammatory/infectious diseases represent the most common feline spinal disorders, followed by neoplastic and traumatic disease processes. Intervertebral disc disease (IVDD) represented only 4% of all cats with a spinal cord disorder[3], while another study indicated that of 92 cats undergoing spinal MRI, only 5 were diagnosed with IVDD.[1] It is therefore not surprising that only a limited number of studies have described the clinical characteristics of feline degenerative IVDD.[4-10] Its prevalence is considered low, no breed or sex predilection has been reported, affected cats are generally older, and prognosis after surgical decompression is considered good.[2,8,9] Although both intervertebral disc extrusions (IVDE), or Hansen type-I IVDD, and intervertebral disc protrusions (IVDP), or Hansen type-II IVDD, have been reported [5,9], its currently unclear if both types of IVDD are associated with different disease characteristics in cats. The situation is different in dogs. Degenerative IVDD is considered the most common and best-characterised canine spinal condition.[11] Numerous studies have evaluated the prevalence of thoracolumbar IVDD among the overall canine population [12], breed-specific risk factors have been identified [12,13], and several studies have reported disease characteristics for dogs with thoracolumbar IVDE or IVDP.[14,15] The overall goal of this study was therefore to evaluate the clinical presentation of feline thoracolumbar IVDD. More specifically the aims of this study were to assess the prevalence and potential breed predisposition of feline thoracolumbar IVDD and evaluate if IVDE and IVDP would be associated with different disease characteristics. It was hypothesised that the prevalence of feline thoracolumbar IVDD

would indeed be low, that purebred cats would have an increased risk to suffer from IVDD, and, similar to the situation in dogs, thoracolumbar IVDE and IVDP would be associated with different disease characteristics.

Material and Methods

The digital medical database of the small animal referral hospital, Royal Veterinary College, University of London was searched for cats diagnosed with thoracolumbar IVDD between January 2008 and August 2014. Search terms included 'intervertebral disc disease', 'disc extrusion', 'disc protrusion', 'disc herniation' and 'disc prolapse'. Thoracolumbar IVDD was defined as IVDE or IVDP between the first thoracic (T1) and seventh lumbar (L7) vertebra. Cats were included if the clinical presentation and magnetic resonance imaging (MRI) studies were both suggestive for degenerative IVDD and if the medical records and imaging studies were available for review. Cats were excluded if the medical records or imaging studies were incomplete or not available for review. Before inclusion, a board-certified neurologist (SDD) reviewed all medical records and imaging studies to evaluate diagnostic accuracy. The following information was retrieved from the medical records: clinical history, signalment, duration, type, and severity of clinical signs, general physical and neurological examination findings, and type of treatment initiated after diagnosis. Type of clinical signs was recorded as spinal hyperaesthesia, ambulatory paraparesis, non-ambulatory paraparesis, or paraplegia as the predominant clinical sign. Gradation of severity of neurological deficits was based on the modified Frankel score [16], and was defined as paraplegia without nociception (grade 0), paraplegia with nociception (grade 1), non-ambulatory paraparesis (grade 2), ambulatory paraparesis and ataxia (grade 3), spinal hyperaesthesia only (grade 4), or no dysfunction. For all included cats, a 1.5T MRI unit (Intera, Philips Medical Systems) was used to obtain a

diagnosis of IVDD. Magnetic resonance imaging was performed under general anaesthesia and included a minimum of T2-weigthed (repetition time [RT] [ms], echo time [TE], [ms] 3333/110) and T1-weighted (TR/TE, 515/15) sagittal and transverse images. Selected products for induction and maintenance of general anaesthesia were at the discretion of the anaesthetist responsible for the case. The location and number of affected intervertebral disc spaces were noted and each intervertebral disc herniation was further characterised as IVDE (or Hansen Type-I disc disease) or IVDP (or Hansen Type-II disc disease). The differentiation between IVDE and IVDP was based on previously evaluated MRI criteria[15] and where possible; the type of IVDD was verified by the surgical reports. More specifically, MRI findings compatible with midline instead of lateralised intervertebral disc herniation and partial instead of complete intervertebral disc degeneration were considered suggestive for IVDP, while a single instead of multiple intervertebral disc herniation and dispersed disc material not confined to the boundaries of the affected intervertebral disc space were considered suggestive for IVDE.[15] Although evaluation of treatment was beyond the scope of this study, medical management typically consisted of a combination of strict rest for 4 weeks and non-steroidal anti-inflammatory drugs, followed by gradual increase in activity over the following 4-6 weeks. Surgical management consisted of a decompressive hemilaminectomy.

Data analysis was performed using standard statistical software package (Prism 6, GraphPad Software Inc., La Jolla, CA). A chi-square test was used to compare the prevalence of purebred and non-purebred cats and to evaluate the prevalence of breeds that were included more than twice in the list of affected breeds (Domestic shorthair, Domestic longhair, British shorthair, and Persian). A Mann Whitney U test was used to compare age, weight, duration of clinical signs, and grade of neurological deficits between cats with IVDE and IVDP. A Fisher's exact test was used to compare gender and presence of spinal hyperaesthesia between cats with IVDE and IVDP. Values of $P < 0.05$ were considered statistically significant.

Results

Of 12900 cats presented during the study period at our referral hospital, 31 were diagnosed with IVDD, including 17 purebred and 14 non-purebred cats. Included breeds were Domestic shorthair, Domestic longhair, British shorthair, Persian, Bengal, Siamese, Havana Brown, Maine Coon, Sphynx, and American Shorthair **(Table 1).** The prevalence of IVDD during the study period was 0.24% for all presented cats overall, 0.15% for all presented non-purebred cats, 0.52% for purebred cats, 1.83% for Persians, and 1.29% for British shorthairs. Compared to the overall feline population, purebred cats (P=0.0001), British shorthairs (P<0.0001), and Persians (P=0.0006) were significantly overrepresented. The group of affected cats included 16 neutered males and 15 neutered females aged between 9 months and 12 years and 4 months (mean, 9 years and 6 months; median, 9 years). The cat affected at 9 months of age had surgically confirmed IVDE. Affected purebred cats were significantly younger than affected non-purebred cats. Included purebred cats were aged between 9 months and 13.7 years (median, 7.6 years), while affected non-purebred cats were aged between 1.3 and 15.3 years (median, 12.2 years). Duration of clinical signs ranged from 12 hours to 6 years (mean, 120 days; median, 15 days) and included spinal hyperaesthesia (n=4), ambulatory paraparesis (n=17), non-ambulatory paraparesis (n=6), and paraplegia (n=4) as the predominant clinical sign. In 23 of 31 cats spinal hyperaesthesia could be elicited on spinal palpation. Severity of neurological deficits varied from grade 0 (n=2), grade 1 (n=2), grade 2 (n=6), grade 3 (n=17), and grade 4 (n=4). There were no significant differences between purebred and non-purebred cats for bodyweight gender, duration and type of clinical signs, severity of neurological deficits, or presence of spinal hyperaesthesia (P>0.05). Magnetic resonance imaging demonstrated a total of 33 intervertebral disc herniations in 31 cats; a single intervertebral disc herniation was seen in 29 cats and two separate intervertebral disc herniations in 2 cats. The

most affected intervertebral disc space was L2-L3 (n=6), followed by T11-T12 (n=5), L3-L4, L6-L7 (n=4 for each), T12-T13, T13-L1, L1-L2 (n=3 for each), T2-T3 (n=2), T8-T9, T9-T10, and L5-L6 (n=1 for each). Of 31 cats with IVDD, 19 were diagnosed with IVDE and 12 with IVDP. Cats with IVDE had a significantly longer duration of clinical signs (mean duration of clinical signs 4 versus 72 days; P=0.0002) and demonstrated more severe neurological deficits (mean neurological grade of 3.2 versus 4.1; P=0.04) compared to cats with IVDP. There was no significant influence of breed, gender, age, or the presence of spinal hyperaesthesia on the type of intervertebral disc herniation (P>0.05). Fifteen cats underwent surgery, 14 cats underwent medical management, and 2 cats were euthanised at the moment of diagnosis without treatment attempted. Surgery confirmed the suspected type of intervertebral disc herniation (IVDE or IVDP) on each occasion. The surgical appearance of IVDE was characterised as sequestered calcified intervertebral disc material without physical connection with the ruptured anulus fibrosus. The surgical appearance of IVDP was characterised by a focal or broad based dorsal displacement of the intervertebral disc without any defect in the outer layers of the anulus fibrosus.

Discussion

This study evaluated the prevalence, possible breed predisposition, and clinical presentation of thoracolumbar IVDD among a population of cats referred to a university teaching hospital. Our results confirm that degenerative IVDD should be considered a rare condition in cats. The prevalence of this disorder was only slightly higher than reported previously.[9] It was 0.24% in the current study, while a previous study documented a prevalence of 0.12% of all cats presented at a North American university teaching hospital.[9] Although other reasons cannot be excluded, this possibly reflects continuous developments in veterinary medicine with advanced

169 imaging procedures, including MRI, performed in an increasing number of cats. Alternatively,
170 the results of our study suggest a possible breed predisposition for feline thoracolumbar IVDD.
171 It can therefore not be excluded that differences in breed distribution among geographical
172 locations has contributed to a difference in disease prevalence. It is currently unclear why cats
173 are only rarely affected by IVDD compared to other domesticated small animals, such as
174 dogs.[12] A recent study, evaluating the histopathological characteristics of the feline
175 intervertebral disc identified possible feline-specific changes in the anulus fibrosus.[17] While
176 the nucleus pulposus demonstrated histological changes comparable to those found in canine
177 intervertebral discs, the feline anulus fibrosus showed distinct depositions of
178 glycosaminoglycans and contained a high degree of chondrocyte-like cells ranging into the
179 outer anulus fibrosus.[17] It is currently however unclear if these changes indeed protect the feline
180 intervertebral disc against degeneration and herniation.

181 In agreement with previous studies, the domestic shorthair was the most common breed to have
182 thoracolumbar IVDD.[2,8,9] However, when taking the relative popularity of the presented breeds
183 into account, purebred cats were significantly overrepresented. More specifically, Persians and
184 British shorthairs were more commonly diagnosed with thoracolumbar IVDD compared to
185 other breeds. It is currently unclear why these specific purebred cats were overrepresented
186 compared to the general hospital population. The aetiology of canine IVDD is considered
187 multifactorial with genetic, anatomical and biomechanical factors involved.[18] Developments
188 in the knowledge of canine IVDD have demonstrated an import role of genetic factors in the
189 development of IVDD.[19-21] Identified genes are associated with the chondrodystrophic
190 phenotype, which is characterised by dogs with relative long spines and short limbs.[19,20] The
191 Dachshund, the dog breed most commonly affected by IVDD, is the prototype of such a 'long
192 and low' chondrodystrophic dog breed and this type of body conformation is indeed considered
193 a major risk factor for the development of thoracolumbar IVDD.[13] The Persian and British

Shorthair are genetically related breeds with the Persian being the foundation breed of the 'Persian family members', which includes the British Shorthair, Scottish Fold, and Selkirk Rex. All these breeds share the brachycephalic structure of the head.[22,23] Although such breed development strategies result in members of different, but closely related, breeds to share the same general and genetic health concerns [23], it remains currently unclear if a relationship exists between the brachycephalic phenotype, other conformational changes, and ultimately, thoracolumbar IVDD. Alternatively, it cannot be excluded that the results of our study do not reflect a true breed predisposition, but rather the willingness of owners of financially more valuable purebred cats to seek referral for advanced diagnostic procedures.

In agreement with previous findings [9], cats with thoracolumbar IVDD were generally old with most affected cats being 8 years or older. The results of this study however demonstrated that affected purebred cats were significantly younger than non-purebred cats. Although this age difference can be considered an illustration of their presumed predisposition for thoracolumbar IVDD, it cannot be excluded this finding represents again an increased willingness of owners to seek referral and pursue expensive diagnostic evaluations in relative younger cats.

In agreement with previous studies [5,9], two types of thoracolumbar intervertebral disc herniation were seen in affected cats; IVDE and IVDP. Intervertebral disc extrusions are characterised by herniation of degenerated and calcified nucleus pulposus through a fully ruptured anulus fibrosus, while IVDP is characterised by a focal and more gradual extension of the anulus fibrosus into the vertebral canal.[18] Although similar histopathological abnormalities are seen in both types of intervertebral disc herniation [24], IVDE and IVDP are associated with different clinical characteristics in dogs.[14,15,25] Intervertebral disc extrusions are typically associated with an acute onset of severe neurological signs, while dogs with IVDP typically present with milder clinical signs and a chronic, progressive clinical history.[14,15,25] In agreement with these findings, cats with IVDE and IVDP demonstrated differences in their

clinical presentation. Cats with IVDE had a shorter duration of clinical signs before presentation and had more severe neurological deficits compared to cats with IVDP. These differences are not surprising and most likely reflect the pathophysiological differences between both types of IVDD. Intervertebral disc extrusions are characterised by a sudden extrusion of calcified and fragmented nucleus pulposus, which results in both contusion and compression of the spinal cord.[26] It is therefore not surprising that affected cats typically demonstrated an acute onset of severe spinal cord dysfunction. In contrast, IVDP is typically associated with gradual spinal cord compression without contusion. Affected cats therefore typically presented with a more gradual onset of milder clinical signs.

Conclusions

Thoracolumbar IVDD should be considered an uncommon disease in cats. Its prevalence is however higher in purebred cats, especially Persians and British Shorthairs. Further studies are necessary to evaluate if this finding represents a true breed predisposition or an increased willingness to pursue advanced diagnostics in financially more valuable pedigree cats. Two types of intervertebral disc herniations, IVDE and IVDP, occur in cats. In agreement with findings in dogs, cats with IVDE present with a shorter duration of clinical signs and milder neurological deficits compared to cats with IVDP.

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243 **Conflict of Interest**

244 The authors do not have any potential conflicts of interest to declare.

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Figure Legends

Table 1. Breed distribution of 31 cats diagnosed with thoracolumbar intervertebral disc disease

Affected breed	**Number of cats**
Domestic shorthair	9
Domestic longhair	5
British Shorthair	5
Persian	4
Bengal	2
Siamese	2
Havana Brown	1
Maine Coon	1
Sphynx	1
American Shorthair	1