



24 Characteristic MRI features included a hyperintense nucleus pulposus signal on T2W  
25 (10/14, 71%) and STIR (11/13, 85%) with contrast-enhancement in all (11/11),  
26 involvement of adjacent vertebral endplates (11/14, 79%), hyperintense neighbouring soft  
27 tissue on T2W (11/14, 79%) and STIR (10/13, 77%) with contrast enhancement in all  
28 (11/11) and presence of spondylosis deformans (10/14, 71%). Other features included  
29 narrowed or collapsed IVDS (8/14, 57%), contrast enhancement of vertebral bodies (5/11,  
30 46%), epidural space involvement (5/14, 36%), compression of the spinal cord or nerve  
31 roots (5/14, 36%), paraspinal abscessation (3/14, 21%) and meningeal signal intensity  
32 abnormalities with contrast-enhancement (5/6, 83%). These latter findings may indicate  
33 secondary focal meningitis.

34 Radiographs were available covering five sites (in 4 cats) and CT covering three sites (in  
35 2 cats). Most common radiological features were collapse or narrowing of the affected  
36 IVDS (80%) and endplate erosion (60%). No changes suggestive for discospondylitis  
37 were identifiable on radiography or CT in two sites (1 cat) despite being identifiable on  
38 MRI. Repeated radiography in one case did not reveal complete radiological resolution  
39 following nine months of treatment.

40 **Conclusions and relevance** The results of this study indicate consistent MRI features of  
41 feline discospondylitis that should be considered in the diagnosis of feline  
42 discospondylitis.

43 **Introduction**

44 Discospondylitis describes the infection of an intervertebral disc (discitis) and its adjacent  
45 cartilaginous vertebral end plates (spondylitis).<sup>1-5</sup> This condition is well recognised and  
46 reported in dogs, with descriptions of its associated clinical signs, typical signalment and  
47 imaging characteristics.<sup>3,4,6</sup> However, literature describing discospondylitis in cats is  
48 sparse with six individual case reports, and two cats being mentioned in a series of feline  
49 patients with spinal cord disease.<sup>7-13</sup> Discospondylitis appears to be a rare condition in  
50 cats, more commonly identified in male cats mainly at the level of the lumbar spine.<sup>7-12</sup>  
51 Prognosis appears guarded as four out of six reported cases died (1 case) or were  
52 euthanased (3 cases) following diagnosis. Reported imaging investigations included  
53 vertebral radiographs in every case with additional computed tomography (CT) or  
54 magnetic resonance imaging (MRI) in single cases.<sup>7,12</sup>

55 Discospondylitis in dogs can be challenging to diagnose as signs are variable and  
56 sometimes vague. Commonly described clinical signs include spinal hyperaesthesia,  
57 lethargy, reluctance to move, pyrexia, anorexia and weight loss.<sup>1,2,5</sup> Neurological  
58 dysfunction can develop, usually secondary to abnormal osseous proliferation, empyema,  
59 focal meningitis/myelitis, subluxation or pathologic fractures.<sup>4,5</sup>

60 Considering the variable and challenging clinical presentation, imaging is critical in  
61 establishing a diagnosis of discospondylitis.<sup>5</sup> A diagnosis of discospondylitis relies on a  
62 combination of compatible clinical signs, exclusion of other painful and debilitating  
63 conditions, culture and sensitivity results, and cytology on any available biopsy material.  
64 However, the clinical conundrum is that to attain a final diagnosis based on  
65 histopathology and culture, imaging features need to be identified, in order to recognise  
66 the need for further procedures. Moreover, blood or urine culture and sensitivity results  
67 have been reported to be negative in about 40-75% of cases of discospondylitis in dogs,

68 with percutaneous disc aspiration yielding positive culture in 75% of dogs.<sup>2,3,14,15</sup> A  
69 definitive diagnosis of discospondylitis in dogs, is therefore based on characteristic  
70 imaging findings in conjunction with compatible clinical signs, ideally in the presence of  
71 a positive culture result.<sup>2,5,16</sup>

72 MRI is considered the investigation method of choice in the diagnosis of discospondylitis  
73 in both people and dogs. It is considered more sensitive and specific than other imaging  
74 techniques, particularly in the early stages of the condition, being able to identify cases  
75 not evident on conventional radiographs.<sup>4-6,17</sup> There is limited literature reporting  
76 diagnostic imaging findings of discospondylitis in cats, particularly with reference to  
77 cross-sectional imaging.

78 The aim of this retrospective study is to describe the MRI features of discospondylitis in  
79 a population of clinically affected cats. Radiography and CT features are discussed and  
80 compared with MRI when available, in order to give stronger guidance for the imaging  
81 diagnosis of feline discospondylitis.

82

83

84 **Material and Methods**

85 **Animals**

86 Medical records of cats diagnosed with both presumptive and confirmed discospondylitis  
87 at three referring institutions between February 2009 and April 2019 were reviewed.

88 Cases were included when presented with (1) clinical signs and history compatible with  
89 discospondylitis, and (2) MRI features suggestive of infection in one or more  
90 intervertebral discs, alone or in conjunction with its adjacent endplates. Compatible  
91 clinical signs included a persistent presence of spinal hyperaesthesia in all cases,  
92 lameness, abnormalities on neurological examination and pyrexia. Since no extensive  
93 literature is available for MRI features of feline discospondylitis, an MRI diagnosis was  
94 based on previously reported imaging characteristics of discospondylitis in a single feline  
95 case report and in two case series of affected dogs.<sup>4,6,12</sup> An MRI diagnosis of  
96 discospondylitis was considered when conformation or signal intensity of an  
97 intervertebral disc space differed, when compared to their adjacent counterparts. The  
98 finding of adjacent vertebral endplates, with an abnormal conformation or signal intensity  
99 also supported the presence of a discospondylitis. All cases presenting an ongoing  
100 suspected or proven neoplastic process and history of trauma were excluded.

101

102 **Imaging**

103 Cross-sectional imaging was performed under general anaesthesia. All cats underwent  
104 CT using a multislice CT machine (Aquilion RXL; Toshiba Medical Systems  
105 Corporation, Tokyo, Japan) and MRI using a low field 0.25 Tesla (T) permanent magnet  
106 (Esaote VetMR Grande, Genova, Italy), a low field 0.4 T (Aperto MRI, Hitachi, Tokyo,  
107 Japan), or a high field 1.5 T (Signa HDe, General Electric, London, UK). MRI studies

108 included a minimum of T2-weighted (T2W) sagittal and transverse images in all cases, a  
109 pre and post-contrast T1-weighted (T1W) and/or short tau inversion recovery (STIR)  
110 dorsal, transverse or sagittal images in the remaining cases. Radiographic and CT studies  
111 were retrieved and assessed when available.

### 112 ***MRI features***

113 MRI features were assessed, with selection of these features being based on reports on  
114 canine discospondylitis and a single feline report.<sup>4,6,12</sup> The intervertebral disc space,  
115 nucleus pulposus, adjacent endplates, vertebral bodies, overlying epidural space,  
116 overlying meninges, paraspinal soft tissues and distal colon were all assessed. The MRI  
117 features assessed are described in Table 1. The epidural space was assessed for presence  
118 of suspected empyema or suspected inflammation of the epidural fat.<sup>4,18</sup> Overlying  
119 meninges were only assessed when high-field images were available, as it was considered  
120 that low-field images did not offer enough resolution to perform this in detail. The  
121 presence of a suspected paraspinal soft tissue abscessation was determined when a focal,  
122 well-demarcated region, presenting a contrast enhancing rim-pattern with an iso-  
123 hypointense center in T2W sequences was detected in direct contact with the affected  
124 intervertebral disc space.<sup>19</sup> Colonic distention was considered subjectively normal or  
125 enlarged. Megacolon was considered if the ratio of maximum colonic diameter compared  
126 to the length of L5 was of more than 1.48.<sup>20</sup> When evidence of discospondylitis was found  
127 on MRI then available radiographic and CT studies of the affected sites were evaluated.

128

### 129 ***Radiographic features***

130 For each case, vertebral radiographs were evaluated if at least a lateral and a ventro-dorsal  
131 projection were available. Assessed features included evidence of endplate erosion,  
132 endplate sclerosis, vertebral body osteolysis, intervertebral disc space morphology

133 (normal, narrowed or collapsed), osseous proliferation adjacent to the intervertebral disc  
134 space, spondylosis and soft-tissue opacity alterations as well as any signs of vertebral  
135 fracture, subluxation or shortening.<sup>4,5,7-10,12</sup> Presence of the vacuum phenomenon was  
136 evaluated and the vertebral region surveyed was noted.<sup>21</sup>

137

### 138 ***Computed tomographic features***

139 Vertebral CT images were evaluated and assessed features included evidence of endplate  
140 erosion, vertebral body osteolysis and its pattern (focal or multifocal punctate osteolysis),  
141 intervertebral disc space morphology (normal, narrowed or collapsed), osseous  
142 proliferation adjacent to the intervertebral disc space, endplate sclerosis, spondylosis,  
143 soft-tissue attenuation alterations, and signs of vertebral fracture, subluxation or  
144 shortening.<sup>7,14,22</sup> Presence of the vacuum phenomena was evaluated and the vertebral  
145 region surveyed was noted.

146

### 147 ***Image assessment and imaging modality comparison***

148 All radiographs, CT and MRI scans were assessed by two of the authors (SG and ML)  
149 independently. When an initial agreement was not attained, features were subsequently  
150 reevaluated and a consensus was reached.

151 Descriptive comparison of the three modalities was performed, detailing cases where  
152 more than one modality was performed. In order to assess the capability of both  
153 radiography and CT in detecting feline discospondylitis when compared with MRI, it was  
154 considered that at least two radiological or CT features had to be identified in order for a  
155 discospondylitis to be suspected based on these imaging modalities alone, e.g. a  
156 narrowed/collapsed intervertebral disc space as well as eroded endplates.

157

158 ***Follow-up***

159 All follow-up repeated imaging studies in all modalities were retrieved if available and  
160 described in detail. Resolution of radiological signs was considered if the lytic focus had  
161 smoothed and disappeared, sclerotic margins had vanished and bridging of the affected  
162 vertebrae was detected on follow-up radiographs.<sup>3</sup>

163

164 **Results**

165 ***Signalment***

166 13 cats were identified with a clinical diagnosis of discospondylitis. Breed distribution  
167 included Domestic Short Hair (n=10), Maine Coon (2) and Siamese (1) with five females  
168 and eight males with a mean age of 107.54 months (median 115, 12 – 168 months).

169

170 Fourteen foci of discospondylitis were identified in the 13 cats, with a single case  
171 presenting with two affected sites. Discospondylitis was identified at L7-S1 in 7/14  
172 (50%), with T12-T13, T13-L1, L1-L2, L2-L3, L3-L4, L5-L6 and L6-L7 being  
173 represented once. In the case with two affected sites these were L1-L2 and L5-L6.

174

175 ***Magnetic resonance imaging findings***

176 High-field MRI was available for 6 cases and low-field MRI in the remaining 7 cases  
177 encompassing 8 sites of discospondylitis. Within the fourteen imaged sites, one case had  
178 no T1W sequences, in another case STIR sequences were not obtained, and in three cases  
179 undergoing low-field MRI a contrast-study was not performed. The signal intensity and  
180 contrast-enhancement features on MRI are detailed in Table 2. Intervertebral disc space  
181 morphology was assessed as normal 6/14 (43%), narrowed 6/14 (43%) or collapsed 2/14  
182 (14%). There was no evidence of a concomitant disc herniation. Adjacent vertebral



183 endplates were considered normal in 3/14 (21%), eroded in 7/14 (50%) and destroyed in  
184 4/14 (29%). Vertebral body involvement was found in 6/14 cases and this was only found  
185 to affect a maximum of a third of the vertebral body. Evidence of vertebral body shape  
186 deformity was found in three cases and vertebral body subluxation was identified in one  
187 case. The epidural space was considered to be involved in five sites with a suspicion of  
188 either an empyema or a local inflammation of the epidural fat with a focal contrast  
189 enhancement in 3/5 sites. Compression of the spinal cord was present in 5/14 sites (36%),  
190 subjectively classified as mild in 4 cases and severe in the remaining case. Concomitant  
191 nerve root compression was observed in three cases. A region compatible with a  
192 suspected abscess in the paraspinal tissues was found in three cases (21%). Ventral  
193 spondylosis deformans was found in 10/14 cases, and the colon was considered  
194 subjectively enlarged in 10/13 cats with two presenting imaging features compatible with  
195 megacolon. Examples of the MRI appearance of feline discospondylitis are depicted on  
196 Figure 1.

197

### 198 ***Radiographic findings***

199 Radiographs were available in four cases covering five discospondylitis sites. All  
200 radiographs were performed concurrent with initial MRI studies, except in one case  
201 covering two sites which was performed two weeks previous. The lumbar region was  
202 included in all cases with the whole vertebral column being radiographed in one case.  
203 Other cases surveyed the full thoracic spine to the tail (1), the thoracolumbar junction to  
204 the tail (1) and from C3 to the tail (1). Evidence of endplate erosion alongside vertebral  
205 body osteolysis was found in 3/5 sites (60%), intervertebral disc space was abnormal in  
206 4/5 sites being narrowed in two and collapsed in the remaining two. A single occurrence  
207 was found of the following findings: endplate sclerosis, spondylosis, soft-tissue opacity,

208 vertebral body shortening and vertebral body subluxation. No osseous proliferation  
209 adjacent to the intervertebral disc space, vertebral body fractures or vacuum phenomena  
210 were identified. Based on these features, clear evidence of discospondylitis was only  
211 found in 3/5 sites (60%). Examples of the radiographic appearance of feline  
212 discospondylitis are depicted on Figure 2.

213

#### 214 ***Computed tomography findings***

215 Computed tomography was performed in two cases covering three discospondylitis sites.  
216 In one case the whole vertebral column was imaged whilst the other included the area of  
217 interest encompassing T7 to the tail. Evidence of endplate erosion was present in one case  
218 (33%) and intervertebral disc space morphology was considered normal in one site and  
219 collapsed in the other two sites (66%). A single occurrence was found of the following  
220 findings: endplate sclerosis, spondylosis deformans and vacuum phenomena within the  
221 affected intervertebral disc. No evidence of soft-tissue attenuation, osseous proliferation,  
222 vertebral body osteolysis, shortening, fractures or subluxations were identified. Based on  
223 these features, clear evidence of discospondylitis was only found in 1/3 sites (33%) (Table  
224 3). Examples of CT appearance of feline discospondylitis are depicted on Figure 3.

225

#### 226 ***Comparison of imaging modalities***

227 When comparing radiographic and MRI findings in five available sites (Table 3), two  
228 sites were not clearly apparent radiographically, since although one of the disc spaces was  
229 collapsed, no evidence of endplate erosion or other associated features were identifiable  
230 in either of them. This occurred in the case in which two discospondylitis foci were  
231 identified on MRI, which was the only case where the three imaging modalities were  
232 performed. Radiographs in this case were performed two weeks previous to MRI study.

233 In these sites, the nucleus pulposus was T2W isointense, STIR hyperintense, with diffuse  
234 contrast-enhancement and paraspinal tissues were involved being hyperintense on both  
235 T2W and STIR sequences. Also CT, performed at the time of MRI diagnosis, did not  
236 suggest discospondylitis due to the lack of endplate or vertebral body changes.  
237 Radiographs provided indication of three discospondylitis sites out of five, by revealing  
238 a combination, amongst other features, of signs of endplate erosion as well as narrowing  
239 or collapse of the affected intervertebral disc space. None of these later cases had a CT  
240 performed.

241 The second case in which a CT was performed, there was clear evidence of endplate  
242 erosion, a collapsed intervertebral disc space, endplate sclerosis, evidence of spondylolisthesis  
243 and ventral spondylosis deformans (Figure 3b). This was further confirmed on MRI in  
244 which a T2W hyperintense nucleus pulposus with rim-contrast enhancement was  
245 identified, with a third of the vertebral body affected.

#### 246 **Follow-up**

247 Repeated imaging studies were only available for one case, in which radiography was  
248 repeated 6 and 9 months following diagnosis and a treatment protocol with antibiotics  
249 (Figure 4). Radiological resolution was not present: there was radiographic evidence of  
250 disappearance and smoothing around a lytic focus, partial replacement by bridging of the  
251 involved vertebrae however sclerotic margins were still detectable on both follow-up  
252 radiographs.

253

254 **Discussion**

255 This report describes the MRI features of discospondylitis in a population of cats,  
256 including its comparison with radiography and CT when available. This study revealed a  
257 series of imaging features which could aid in the detection of discospondylitis in cats.

258

259 Feline discospondylitis had been previously reported in six individual case reports and  
260 two cats being described in a series of feline patients with spinal cord disease.<sup>7-13</sup>

261 Previously reported affected disc spaces in these cats were L7-S1 (3), L3-L4 (2), L4-L5  
262 (2) and L2-L3 (1), with two cats presenting multiple affected discs. This study confirms  
263 the suspicion that L7-S1 seems to be an intervertebral disc particularly susceptible to  
264 discospondylitis in cats, making up 50% of our reported population and making up almost  
265 half of the totality of reported cases. The L7-S1 intervertebral disc space is also described  
266 as the most commonly affected site in dogs.<sup>2-4</sup> We also report the first two instances of  
267 feline thoracic discospondylitis (T12-T13 and T13-L1).

268

269 MRI features of discospondylitis in dogs have been described previously and have been  
270 found to be generally consistent, although individual variability has been reported.<sup>4-6</sup> In  
271 the sole feline discospondylitis report with MRI findings, the intervertebral disc was T2W  
272 hyperintense and T1W isointense, and the vertebral endplates were T2W and T1W  
273 hypointense.<sup>12</sup> Marked contrast-enhancement of the L7 and S1 endplates and surrounding  
274 soft tissues was evident. A subjectively distended distal colon was also reported.<sup>12</sup>

275

276 Magnetic resonance features of discospondylitis in cats appeared to be fairly consistent  
277 within the population described in this study, although individual variability was  
278 apparent. Intervertebral disc space morphology was altered in 57% of cases. Nucleus

279 pulposus signal was found to be mainly hyperintense on both T2W and STIR sequences  
280 with signal void occasionally seen on T2W images. T1-weighted sequences were  
281 typically isointense, contrast uptake was noticeable in every case where this was  
282 available. Affected vertebral endplates were irregularly eroded or completely destroyed.  
283 Vertebral bodies were mostly unaffected, with the majority failing to enhance following  
284 intravenous contrast injection. The neighbouring soft tissues were often abnormal, with  
285 T2W and STIR hyperintensity and contrast enhancement present in every case where this  
286 was available. These MRI findings were mostly compatible with the MRI features  
287 described for dogs.<sup>4,6</sup> In contrast, epidural space involvement and compression of the  
288 spinal cord or nerve roots was found in 36% of cases (5/14), which differs from dogs  
289 where both were found more commonly.<sup>4,6</sup> Overlying meningeal signal intensity  
290 abnormalities were common with contrast-enhancement present in all five cases,  
291 indicating that discospondylitis in cats relates to a secondary focal meningitis. Other  
292 findings were the presence of areas compatible with paraspinal abscessation in 21% of  
293 cases, and a high prevalence of ventral spondylosis deformans (71%).

294 Radiographic features previously described in feline patients included vertebral endplate  
295 lysis and /or sclerosis, a narrowed or collapsed intervertebral disc space, spondylosis  
296 deformans, irregular bone proliferation ventrally to the affected disc, an increase in  
297 ventral soft-tissue opacity, and subluxation at the level of the L7-S1 joint. All of these  
298 features, except for bone proliferation, were found in our population of cats. Vertebral  
299 body shortening is a new feature associated with discospondylitis in our subset of patients.  
300 The most common radiographic feature was collapse or narrowing of the affected  
301 intervertebral disc space (80%), with endplate erosion seen in 60% of radiographs.  
302 Radiographic evidence of intervertebral disc space narrowing has been reported in cats  
303 suffering from other conditions such as intervertebral disc disease and acute non-

304 compressive nucleus pulposus extrusion.<sup>23-25</sup> However, when evidence of intervertebral  
305 disc space narrowing is identified in a cat with spinal hyperaesthesia, particularly in the  
306 presence of endplate erosion, discospondylitis should be included in the list of differential  
307 diagnoses. Interestingly in one of the cases previously reported, discospondylitis was  
308 identified post-mortem, and had not been identified on either survey radiographs or  
309 myelography.<sup>11</sup> In our population there were two affected sites in which radiography and  
310 CT failed to reveal characteristics relating to discospondylitis when changes were present  
311 on MRI. In dogs, there is a reported delay in development of radiographic signs with  
312 additional cross-sectional imaging often necessary to make a diagnosis.<sup>5</sup> The presence of  
313 discospondylitis with minimal or no changes on radiographs and CT, would support the  
314 same assertion in feline patients. However, further cases might be required to confirm this  
315 in view of the small number of cases having had all imaging modalities.

316

317 Computed tomography findings of discospondylitis in both cats and dogs include the  
318 same features as plain radiography with the addition of being able to identify areas of  
319 punctate osteolysis within the endplates with or without osteolysis of the adjacent  
320 bone.<sup>7,14,22</sup> In one previously reported cat, contrast CT identified a rim contrast-  
321 enhancement mass compatible with an abscess next to the affected disc.<sup>7</sup> Computed  
322 tomography has clear advantages over plain radiography offering a more detailed  
323 depiction of bone with the potential of identifying osseous lesions earlier in the course of  
324 disease.<sup>5</sup> However, in one of our cases there was a time-lapse of two weeks between  
325 radiography and both CT and MRI. In this case there was no evidence of changes on  
326 radiography besides a reduced intervertebral disc space. An argument could be made that  
327 radiological features had not yet developed, however a CT performed at the same time as  
328 MRI also failed to detect radiological features supportive of discospondylitis (Figure 3,

329 a<sub>1</sub> and a<sub>2</sub>). In our population of cats, CT findings were compatible with previous reports,  
330 with a reduced intervertebral disc space being the most repeatable finding. Interestingly  
331 the vacuum phenomenon was identified within one of the affected intervertebral discs.  
332 This is a radiographic feature most commonly associated with intervertebral disc  
333 extrusion.<sup>26</sup> This is the first reported occurrence of this sign in a feline discospondylitis  
334 patient, although it has previously been reported in canine discospondylitis.<sup>21</sup> Although  
335 radiography lacked sensitivity for the detection of discospondylitis, CT also failed to  
336 identify discospondylitis detected on MRI in two out of the three imaged sites. Further  
337 studies utilising CT in feline discospondylitis would be required to further assess its  
338 potential diagnostic value.

339

340 The presence of infectious processes of the vertebral column in cats, such as empyema,  
341 have previously been reported in cats in the absence of a concurrent discospondylitis.<sup>27-</sup>  
342 <sup>30</sup> Feline discospondylitis, however, has been reported concomitantly to paravertebral  
343 abscesses and meningomyelitis.<sup>7,9,11</sup> Within our population, the subset of patients  
344 presenting contrast-enhancing regions within the epidural space, meninges or paraspinal  
345 soft tissues could have presented with abscessation or even meningomyelitis. When such  
346 regions were identified in the epidural space, these were considered to either be a sign of  
347 an empyema or inflammation of the epidural fat. The presence of these concomitant and  
348 adjacent infectious loci could be explained by the close proximity of these structures  
349 allowing direct spread of an infectious agent.

350

351 Imaging evidence of a subjectively enlarged colon was found in the majority of cases,  
352 with megacolon found in 15%. Although some faecal retention is to be expected in cases  
353 presenting with spinal pain, the clinical significance of this later finding is unknown.

354 Further clarification would require further studies describing clinical presentation and  
355 treatment of feline discospondylitis and other spinal cord disorders.

356

357 Follow-up imaging was only available in one case with repeated radiographs six and nine  
358 months following diagnosis. In dogs, evidence of radiological resolution of  
359 discospondylitis was only achieved following treatment for a period of  $53.7 \pm 45.4$   
360 weeks.<sup>3</sup> In our case there was evidence of a partial resolution of the radiological signs at  
361 nine months. Further studies will be required to demonstrate if radiological resolution in  
362 the feline population is similar to that reported in dogs. Follow-up cross-sectional  
363 imaging, particularly MRI, may have the potential to predict clinical resolution, treatment  
364 length and relapse in both feline and canine discospondylitis.

365

366 A number of limitations exist in the current study. Data were collected retrospectively,  
367 and therefore imaging acquisition protocols and equipment were not standardised.  
368 Diagnosis of discospondylitis relied on clinical features and MRI evidence of a suspected  
369 infectious process affecting the intervertebral disc spaces and/or the vertebral endplates.  
370 Therefore MRI was utilised as an inclusion criteria and it could therefore not be compared  
371 in terms of sensitivity and specificity with the other imaging modalities. There may have  
372 been cases in which MRI did not reveal any changes where a diagnosis of discospondylitis  
373 could have been missed. However, imaging is critical in making a diagnosis of  
374 discospondylitis and even if no abnormalities are found at an initial MRI, these should  
375 develop as the condition progresses.<sup>5</sup> A full vertebral column study was not performed in  
376 most cases, leaving the potential for other affected intervertebral discs being overlooked.  
377 This can be explained by costs associated with advanced imaging and investigation based  
378 on an area of interest identifiable either through a clear neurolocalisation or an indication



379 of a neurolocalisation based on spinal hyperaesthesia. We would recommend that when  
380 a focus of discospondylitis is detected, imaging of the entire vertebral column is  
381 performed in search of other possible foci of infection. Only a small number of  
382 radiographs and CT studies were available in relation with MRI studies, which limited  
383 the comparison within modalities. Follow-up study was only available in one case and  
384 further information could have been gathered with an increased number of cases.

385

### 386 **Conclusions**

387 This is the largest reported population of cats diagnosed with discospondylitis. A set of  
388 MRI features are described, indicating a series of consistent findings that might be helpful  
389 in the diagnosis of discospondylitis in cats. Although only a few cases had all imaging  
390 modalities performed, the findings in this study support the notion that MRI should be  
391 considered the investigation method of choice in the diagnosis of discospondylitis in  
392 feline patients, as is presently considered in both dogs and humans. Where only  
393 radiography is available, evidence of intervertebral disc space narrowing in conjunction  
394 with adjacent endplate irregularities should be considered a strong indication for the  
395 presence of discospondylitis, and further advanced imaging should be performed.

396

### 397 **Conflict of interest**

398 The authors declared no potential conflicts of interest with respect to the research,  
399 authorship, and/ or publication of this article.

400

### 401 **Funding**

402 The authors received no financial support for the research, authorship, and/or publication  
403 of this article.

404

405 **Ethical approval**

406 This work involved the use of client-owned animals only, and followed established  
407 internationally recognised high standards ('best practice') of individual veterinary clinical  
408 patient care. Ethical Approval from a committee was not therefore needed.

409


410 **Informed consent**

411 Written informed consent was obtained from the owner or legal guardian of all animals  
412 described in this work for the procedures undertaken.

413

414 **References**

- 415 1 Moore MP. Discospondylitis. *Vet Clin North Am Small Anim Pract* 1992; 22(4):  
416 1027-1034.
- 417 2 Thomas WB. Diskospondylitis and other vertebral infections. *Vet Clin North Am*  
418 *Small Anim Pract* 2000; 30(1): 169-82.
- 419 3 Burkert AB, Kerwin SC, Hosgood GL, et al. Signalment and clinical features of  
420 diskospondylitis in dogs: 513 cases (1980–2001). *J Am Vet Med Assoc* 2005; 227:  
421 268–275.
- 422 4 Carrera I, Sullivan M, McConnell F, et al. Magnetic resonance imaging features of  
423 diskospondylitis in dogs. *Vet Radiol Ultrasound* 2011; 52: 125–131.
- 424 5 Ruoff CM, Kerwin SC and Taylor AR. Diagnostic imaging of diskospondylitis. *Vet*  
425 *Clin North Am Small Anim Pract* 2018; 48(1): 85-94.
- 426 6 Harris JM, Chen AV, Tucker RL, et al. Clinical features and magnetic resonance  
427 imaging characteristics of diskospondylitis in dogs: 23 cases (1997–2010). ). *J Am*  
428 *Vet Med Assoc* 2013; 242(3): 359-365.
- 429 7 Packer RA, Coates JR, Cook CR, et al. Sublumbar abscess and diskospondylitis in a  
430 cat. *Vet Radiol Ultrasound* 2005; 46: 396–399.
- 431 8 Norsworthy GD. Diskospondylitis as a cause of posterior paresis. *Feline Pract* 9:39–  
432 40, 1979
- 433 9 Malik R, Latter M and Love DN. Bacterial diskospondylitis in a cat. *J Small Anim*  
434 *Pract* 1990; 31: 404–406.
- 435 10 Watson E, Roberts RE. Diskospondylitis in a cat. *Vet Radiol Ultrasound* 1993; 34:  
436 397–398.
- 437 11 Aroch I, Shamir M and Harmelin A. Lumbar diskospondylitis and meningomyelitis  
438 caused by *Escherichia coli* in a cat. *Feline Pract* 1999; 27: 20-22.

- 439 12 Hill MF, Warren-Smith C and Granger N. What is your diagnosis?  
440 Diskospondylitis. *J Am Vet Med Assoc* 2015; 247: 743–745. 
- 441 13 Gonçalves R, Platt SR, Llabrés-Díaz FJ, et al. Clinical and magnetic resonance  
442 imaging findings in 92 cats with clinical signs of spinal cord disease. *J Feline Med  
443 Surg* 2009; 11: 53–59.
- 444 14 Gonzalo-Orden JM, Altonaga JR, Asuncion Orden M et al. Magnetic resonance,  
445 computed tomographic and radiologic findings in a dog with diskospondylitis. *Vet  
446 Radiol Ultrasound* 2000; 41(2), 142–144.
- 447 15 Fischer A, Mahaffey MB and Oliver JE. Fluoroscopically Guided Percutaneous  
448 Disk Aspiration in 10 Dogs With Diskospondylitis. *J Vet Intern Med* 1997; 11(5):  
449 284–287.
- 450 16 Tipold A, Stein VM. Inflammatory Diseases of the Spine in Small Animals. *Vet  
451 Clin North Am Small Anim Pract* 2010; 40(5): 871–879.
- 452 17 Maiuri F, Gallicchio B, Manto A, et al. Spondylodiscitis: clinical and magnetic  
453 resonance diagnosis. *Spine* 1997; 22(15): 1741-1746.
- 454 18 Cornelis I, De Decker S, Gielen I, et al. Idiopathic sterile inflammation of the  
455 epidural fat and epaxial muscles causing paraplegia in a mixed-breed dog. *J Am Vet  
456 Med Assoc* 2013; 242(10): 1405–1409.
- 457 19 Naughton JF, Tucker RL and Bagley RS. Radiographic diagnosis – paraspinal  
458 abscess in a dog. *Vet Radiol Ultrasound* 2005; 46(1): 23–26.
- 459 20 Trevail T, Gunn-Moore DA, Carrera I, et al. Radiographic diameter of the colon in  
460 normal and constipated cats and in cats with megacolon. *Vet Radiol Ultrasound*  
461 2011; 52(5): 516-20.
- 462 21 Weber WJ, Berry CR and Kramer RW. Vacuum phenomenon in twelve dogs. *Vet  
463 Radiol Ultrasound* 1995, 36(6), 493–498.

- 464 22 De Risio L, Gnudi G and Bertoni G. What is your diagnosis? Sclerosis of the caudal  
465 vertebral body end plate of L7 and the cranial end plate of S1 and narrowing of the  
466 L7-S1 intervertebral disk space. *J Am Vet Med Assoc* 2003; 222: 1359–60.
- 467 23 Kathmann I, Cizinauskas S, Rytz U, et al. Spontaneous Lumbar Intervertebral Disc  
468 Protrusion in Cats: Literature Review and Case Presentations. *J Feline Med Surg*  
469 2000; 2(4): 207–212.
- 470 24 Knipe M, Vernau K, Hornof W, et al. Intervertebral Disc Extrusion in Six Cats. *J*  
471 *Feline Med Surg* 2001; 3(3), 161–168.
- 472 25 Chow K, Beatty JA, Voss K, et al. Probable lumbar acute non-compressive nucleus  
473 pulposus extrusion in a cat with acute onset paraparesis. *J Feline Med Surg* 2012;  
474 14(10): 764-767.
- 475 26 Müller MK, Ludewig E, Oechtering G, et al. The vacuum phenomenon in  
476 intervertebral disc disease of dogs based on computed tomography images. *J Small*  
477 *Anim Pract* 2013; 54(5): 253-257.
- 478 27 Granger N, Hidalgo A, Leperlier D, et al. Successful treatment of cervical spinal  
479 epidural empyema secondary to grass awn migration in a cat. *J Feline Med Surg*  
480 2007; 9(4): 340–345.
- 481 28 Maeta N, Kanda T, Sasaki T, et al. Spinal epidural empyema in a cat. *J Feline Med*  
482 *Surg* 2010; 12(6): 494–497.
- 483 29 Rapoport K, Shamir MH, Bibring U, et al. Epidural Spinal Empyema and Vertebral  
484 Osteomyelitis in a Cat. *ISR J VET MED* 2016; 71(4): 41-44.
- 485 30 Guo S, Lu D. Clinical presentation, diagnosis, treatment and outcome of spinal  
486 epidural empyema in four cats (2010 to 2016). *J Small Anim Pract*. Epub ahead of  
487 print 02 November 2018.
- 488

489 **Tables**

490

491 **Table 1. MRI features assessed**

492

<b>Region of interest</b>	<b>MRI features based on Carrera <i>et al.</i> 2010 and Harris <i>et al.</i> 2013</b>
Intervertebral disc space (IVDS)	Number and location of affected intervertebral discs.
	Morphology (normal, narrowed or collapsed in comparison with contiguous IVDS).
	Presence of intervertebral disc herniation.
	Presence of ventral spondylosis deformans.
Intervertebral disc nucleus pulposus	Intensity on T2W, T1W and STIR compared to adjacent discs.
	Contrast-enhancement pattern (focal, diffuse, rim-enhancement or absent)
Adjacent endplates	Intact / eroded (hypointense signal alongside normal signal intensity of the adjacent marrow) / destroyed (both cortical and adjacent marrow signal disruption)
Vertebral body	Intensity on T2W, T1W and STIR compared with normal vertebral bone marrow.
	Extent of abnormalities (one-third, two-thirds, complete).
	Contrast-enhancement pattern (as described above).
	Morphology (presence of deformity or subluxation).
Epidural space	Presence of suspected empyema / epidural fat inflammation.
	Contrast-enhancement pattern (as described above).
	Spinal cord compression (mild, moderate, severe).
	Nerve root compression.
Meninges	Intensity on T2W, T1W and STIR.
	Contrast-enhancement pattern (as described above).
Paraspinal tissues	Intensity on T2W, T1W and STIR.
	Contrast-enhancement pattern (as described above).
	Suspected abscess presence.
Colonic distention	Normal, enlarged or megacolon.

493

494

495

496 **Table 2. Overview of the MRI signal intensity features of feline discospondylitis**  
 497 **found in this study. The most frequent finding in each category is highlighted**

	<b>T2-weighted</b>	<b>T1-weighted</b>	<b>STIR</b>	<b>T1-weighted post-contrast pattern or presence</b>
<b>Intervertebral disc nucleus pulposus</b>	<b>Hyperintense</b> 10/14 (71%) Isointense 1/14 (7%) Hypointense 2/14 (14%) Not identifiable 1/14 (7%)	Hyperintense 0/13 (0%) <b>Isointense</b> 9/13 (69%) Hypointense 3/13 (23%) Not identifiable 1/13 (8%)	<b>Hyperintense</b> 11/13 (85%) Isointense 1/13 (8%) Hypointense 0/13 (8%) Not identifiable 1/13 (8%)	Absent 0/11 (0%) Focal 2/11 (18%) <b>Diffuse</b> 6/11 (55%) Rim-like 3/11 (27%)
<b>Vertebral body</b>	Hyperintense 0/14 (0%) <b>Isointense</b> 11/14 (79%) Hypointense 3/14 (21%)	Hyperintense 0/13 (0%) <b>Isointense</b> 9/13 (69%) Hypointense 4/13 (31%)	Hyperintense 3/13 (23%) <b>Isointense</b> 10/13 (77%) Hypointense 0/13 (0%)	<b>Absent</b> 6/11 (55%) Focal 5/11 (46%) Diffuse 0/11 (0%) Rim-like 0/11 (0%)
<b>Paraspinal tissues</b>	<b>Hyperintense</b> 11/14 (79%) Isointense 3/14 (21%) Hypointense 0/14 (0%)	Hyperintense 0/13 (0%) <b>Isointense</b> 13/13 (100%) Hypointense 0/13 (0%)	<b>Hyperintense</b> 10/13 (77%) Isointense 3/13 (23%) Hypointense 0/13 (0%)	Absent 1/11 (9%) Focal 3/11 (27%) <b>Diffuse</b> 7/11 (64%) Rim-like 0/11 (0%)
<b>Meninges (only evaluated in high-field imaging)</b>	<b>Hyperintense</b> 5/6 (83%) Isointense 1/6 (17%) Hypointense 0/6 (0%)	Hyperintense 0/6 (0%) <b>Isointense</b> 5/6 (83%) Hypointense 1/6 (17%)	<b>Hyperintense</b> 4/5 (80%) Isointense 1/5 (20%) Hypointense 0/5 (0%)	<b>Present</b> 5/6 (83%)
<b>Epidural space</b>	Found involved in 5/14 (36%) cases			Absent 0/5 (0%) <b>Focal</b> 3/5 (60%) Diffuse 2/5 (40%) Rim-like 0/5 (0%)

498

499 **Table 3. Comparison of different imaging modalities in the available cases**

	<b>Lesion location</b>	<b>MRI demonstrable</b>	<b>CT demonstrable</b>	<b>Radiographically demonstrable</b>	<b>Repeat radiography</b>
<b>Cat 1</b>	L7-S1	√		√	
<b>Cat 2</b>	L1-L2	√	x	x	
<b>Cat 2</b>	L5-L6	√	x	x	
<b>Cat 3</b>	L2-L3	√		√	
<b>Cat 4</b>	L7-S1	√		√	√
<b>Cat 5</b>	L7-S1	√	√		

500

501

502 **Figures**

503

504 **Figure 1.** Three examples of feline discospondylitis on sagittal plane MRI: (a)  
 505 discospondylitis present at L3-L4 (arrow) acquired on high-field MRI: A<sub>1</sub> T2-weighted,  
 506 A<sub>2</sub> T1-weighted pre-contrast, A<sub>3</sub> T1-weighted post-contrast; (b) discospondylitis present

507 at T12-T13 (arrow) acquired on low-field MRI: B<sub>1</sub> T2-weighted, B<sub>2</sub> T1-weighted pre-  
508 contrast, B<sub>3</sub> T1-weighted post-contrast; (c) discospondylitis present at L2-L3 (arrow)  
509 acquired on high-field MRI: C<sub>1</sub> T2-weighted, C<sub>2</sub> T1-weighted pre-contrast, C<sub>3</sub> T1-  
510 weighted post-contrast

511

512 **Figure 2.** Two examples of feline discospondylitis identifiable on radiography. (a) L2-  
513 L3 discospondylitis (arrow): A<sub>1</sub> lateral projection, A<sub>2</sub> ventro-dorsal projection. There is  
514 loss of normal endplate morphology, left lateral bone proliferation (arrow) and  
515 intervertebral disc space narrowing –endplate erosion with evidence of a reduced foramen  
516 at this level confirms a narrower space in comparison with adjacent spaces. (b) L7-S1  
517 discospondylitis (arrow): B<sub>1</sub> lateral projection, B<sub>2</sub> ventro-dorsal projection. There is  
518 endplate destruction and sclerosis, evidence of subluxation, osteolytic lesion at the S1  
519 vertebral body and collapse of the intervertebral disc space at this level. A subjectively  
520 enlarged distal colon is also identifiable (\*)

521

522 **Figure 3.** Two examples of feline discospondylitis identifiable on computed tomography.  
523 (a) L5-L6 discospondylitis (arrow): A<sub>1</sub> sagittal plane, A<sub>2</sub> dorsal plane. Narrowing of the  
524 intervertebral disc space is identifiable without endplate erosion. (b) L7-S1  
525 discospondylitis (arrow): B<sub>1</sub> sagittal plane, B<sub>2</sub> dorsal plane. There is endplate sclerosis,  
526 collapse of the intervertebral disc space and evidence of spondylosis deformans ventral  
527 to the affected disc. A subjectively enlarged distal colon is also identifiable (\*)

528

529 **Figure 4.** L7-S1 feline discospondylitis identifiable on repeated radiography following  
530 treatment with antibiotics: a1 (initial), a2 (6 months later), a3 (9 months later). Full  
531 radiological resolution was not present despite clinical resolution



532

533

