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Clinical characterization of thoracolumbar and lumbar intervertebral disk extrusions in English Cocker Spaniels

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OBJECTIVE

To assess the anatomic distribution of thoracolumbar and lumbar intervertebral disk extrusions (IVDEs) in English Cocker Spaniels as compared with findings in Dachshunds and to characterize clinical findings in English Cocker Spaniels with thoracolumbar or lumbar IVDEs affecting various regions of the vertebral column.

DESIGN

Retrospective observational study.

ANIMALS

81 English Cocker Spaniels and 81 Dachshunds with IVDEs.

PROCEDURES

Signalment, clinical signs, neurologic examination findings, and affected intervertebral disk spaces (IVDSs) were recorded for both breeds. Management methods and outcomes were recorded for English Cocker Spaniels. Lesions were categorized as thoracolumbar (IVDSs T9-10 through L1-2), midlumbar (L2-3 through L4-5), or caudal lumbar (L5-6 through L7-S1).

RESULTS

Midlumbar and caudal lumbar IVDEs were significantly more common in English Cocker Spaniels than in Dachshunds. English Cocker Spaniels with caudal lumbar IVDEs had a longer median duration of clinical signs before evaluation and more commonly had unilateral pelvic limb lameness or spinal hyperesthesia as the predominant clinical sign than did those with IVDEs at other sites. Those with caudal lumbar IVDEs less commonly had neurologic deficits and had a higher median neurologic grade (indicating lesser severity), shorter mean postoperative hospitalization time, and faster mean time to ambulation after surgery than those with other sites affected. These variables did not differ between English Cocker Spaniels with thoracolumbar and midlumbar IVDEs.

CONCLUSIONS AND CLINICAL RELEVANCE

Caudal and midlumbar IVDEs were more common in English Cocker Spaniels than in Dachshunds. English Cocker Spaniels with caudal lumbar IVDE had clinical signs and posttreatment responses that differed from those in dogs with midlumbar or thoracolumbar IVDE. (*J Am Vet Med Assoc* 2016;248:405–412)

Thoracolumbar or lumbar IVDE is a common vertebral column disorder in dogs.[1,2] Although any dog can be affected, chondrodystrophic breeds are predisposed, with Dachshunds overrepresented in recent studies.[2–5] Thoracolumbar IVDE is therefore best characterized in this breed. Whereas the estimated lifetime prevalence of intervertebral disk disease is 2% to 3.5% in the overall dog population, it is estimated to be 19% to 25% for Dachshunds.[2,6,7] Dachshunds most commonly develop clinical signs between 4 and 6 years of age, and IVDEs typically occur in the region of the thoracolumbar junction, with the IVDSs between T11-12 and L2-3 most often affected.[3,4,8–12] English Cocker Spaniels are also predisposed to IVDE, and this breed is among the 7 breeds at highest risk for this disorder.[2,5,6,13,14] Although anecdotal information suggests a higher incidence of lumbosacral IVDEs in English Cocker Spaniels than in other dog breeds,[15] little is known about characteristics of thoracolumbar and lumbar IVDE in this breed. Therefore, the purpose of the study reported here was to characterize the clinical signs and findings associated with IVDE of these regions in English Cocker Spaniels. As part of this evaluation, we sought to compare the anatomic distribution of thoracolumbar IVDE and lumbar IVDE between Dachshunds and English Cocker Spaniels. We hypothesized that English Cocker Spaniels would have a higher frequency of IVDEs in the caudal lumbar portion of the vertebral column, compared with that in

ABBREVIATIONS

IVDE	Intervertebral disk extrusion
IVDS	Intervertebral disk space

Dachshunds, and that among English Cocker Spaniels, dogs with IVDE in the caudal lumbar region would have different clinical signs and would less commonly have neurologic deficits, compared with those with IVDE in the thoracolumbar and midlumbar regions.

Materials and Methods

Case selection and medical records review

The electronic medical records of the University of London Royal Veterinary College Small Animal Referral Hospital were searched to identify English Cocker Spaniels with IVDEs that were initially diagnosed between January 1, 2007, and February 28, 2014. Cases were included if dogs had clinical signs, neurologic examination results, and diagnostic imaging findings consistent with IVDE between the T9 and S1 vertebrae. Dogs were excluded from the study if the clinical records were incomplete or diagnostic images were incomplete or unavailable for review. For dogs seen at the referral hospital during the study period with > 1 episode of confirmed IVDE, only information from the first visit was used. An equal number of Dachshunds evaluated during the study period was selected from the study hospital's electronic medical records by use of a random numbers generator. The same criteria as for English Cocker Spaniels were used to select cases for study inclusion. The study was approved by the Royal Veterinary College Ethics and Welfare Committee (protocol number URN 2014 0109H).

Information retrieved from the medical records included signalment, duration, type and severity of clinical signs, treatment received before referral, general physical and neurologic examination findings, presence and type of neurologic deficits, and results of diagnostic tests, including diagnostic imaging. The predominant clinical sign was recorded as spinal hyperesthesia, unilateral pelvic limb lameness, pelvic limb ataxia, ambulatory paraparesis, nonambulatory paraparesis, or paraplegia. Neurologic deficits were defined as one or more of the following: proprioceptive deficits, reduced pelvic limb spinal reflexes, reduced perianal reflex, reduced anal tone, reduced tail tone, and reduced nociception of the tail, perianal region, or digits. Neurologic status was graded by the modified Frankel score,[16,17] which was defined as paraplegia with no deep nociception (grade 0), paraplegia with no superficial nociception (grade 1), paraplegia with nociception (grade 2), nonambulatory paraparesis (grade 3), ambulatory paraparesis and ataxia (grade 4), spinal hyperesthesia only (grade 5), or no dysfunction. The affected IVDS identified by diagnostic imaging findings was recorded, and IVDE sites were categorized by vertebral column region as thoracolumbar (T9-10 through L1-2 IVDSs), midlumbar (L2-3 through L4-5), or caudal lumbar (L5-6 through L7-S1 IVDSs). For the purpose of this study, dogs with lumbosacral (L7-S1) IVDE were included in the group of dogs with caudal lumbar IVDE.

Treatment and outcome data were collected only for English Cocker Spaniels. Types of treatment, possible complications related to treatment, duration of hospitalization, and clinical status at the time of discharge were retrieved from the medical records. Short-term follow-up information was retrieved from the medical records of reexamination visits 4 to 6 weeks after the diagnosis of IVDE was made. Long-term follow-up was defined as a follow-up period of ≥ 3 months.[18] This information was initially obtained via telephone interview with the referring veterinarians. For the dogs that had died, date and cause of death as well as the last documented neurologic status were recorded. Conforming to local ethics and welfare committee guidelines, only owners of dogs that were believed to be alive at the time of data collection were subsequently contacted. Owners were mailed a letter with study details and a standardized questionnaire that had been reviewed and approved by the Royal Veterinary College Ethics and Welfare committee. Telephone interviews were conducted by an investigator following the questionnaire, which was created on the basis of questions in previously described questionnaires developed to assess outcome for dogs with spinal disease and included questions covering specific aspects of the disease, such as signs of pain; amount of activity; lameness, paresis, and incontinence; type of medical and surgical treatment received; and response to treatment.[19] A successful outcome was defined as resolution or improvement of clinical signs with the dog being able to ambulate independently, being able to control urination and defecation, and considered by the owner to have no signs of pain.

Diagnostic imaging and treatment

Diagnosis of IVDE was made by evaluation of myelographic, CT, or MRI results for dogs under general anesthesia. Myelography was performed in dogs following intrathecal injection of iohexol[a] contrast medium (0.2 mL/kg [0.09 mL/lb] with a maximal dose of 10 mL) through the L5-6 interspace. The complete vertebral column was imaged during myelography, and radiographs were obtained in orthogonal and oblique views. The CT imaging was performed with a 16-slice helical CT scanner[b] (slice thickness, 2 mm; 1 interval between slices; voltage peak, 140 kVp; current, 120 mA); dogs were positioned in dorsal recumbency, and all scans were performed with bone and soft tissue reconstruction algorithms. After completion of the transverse CT scan, sagittal and dorsal reconstructions were made. For MRI, a 1.5T unit[c] was used. Dogs were placed in dorsal recumbency, and protocols included a minimum of T2-weighted (repetition time, 3,000 milliseconds; echo time, 120 milliseconds) and T1-weighted (repetition time, 400 milliseconds; echo time, 8 milliseconds) sagittal and transverse images. Slice thickness for sagittal and transverse images was 1.75 and 2.5 mm, respectively, with an interslice gap of 0.3 mm in both planes.

Surgical management included hemilaminectomy or dorsal laminectomy, depending on the affected IVDS. Perioperative anesthetic and analgesic treatments were at the discretion of the anesthetist and clinician responsible for the case. Postoperative care consisted of restricted exercise for 4 weeks in combination with physiotherapy and anti-inflammatory and analgesic medication as determined appropriate for each patient. Medical management consisted of strict rest for 4 to 6 weeks in combination with appropriate anti-inflammatory and analgesic medication.

Statistical analysis

Computations were performed with statistical software.[d] All variables were treated as categorical, except for age, weight, duration of clinical signs, and hospitalization, which were continuous. Univariate statistical comparisons between English Cocker Spaniels versus Dachshunds were carried out. Relationships between categorical variables (eg, sex, neuter status, and presence or absence of neurologic deficits) were explored by means of a χ^2 test for independence with a Yates correction for continuity.

Distribution of data was assessed by the Shapiro-Wilk test. Differences between normally distributed continuous variables were explored with an independent *t* test with a Levine test for equality of variances. Differences between nonnormally distributed continuous data were assessed with a Mann-Whitney test. Variables were considered for inclusion in binary logistic regression if $P < 0.30$. Significant findings are presented with ORs and 95% confidence intervals.

For the English Cocker Spaniels, associations of IVDE location with signalment, clinical signs, treatment, and outcome were evaluated via 1-way ANOVA and Kruskal-Wallis tests with posttests for normally and nonnormally distributed data, respectively. Data for dogs that had multiple IVDEs diagnosed during 1 visit were not included in statistical analysis. Additional pairwise comparisons were performed as required with the Bonferroni adjustment. Values of $P < 0.05$ were considered significant. Normally distributed data are presented as mean ± SD, and nonnormally distributed data are reported as median and range unless otherwise indicated.

Results

English Cocker Spaniels

Eighty-one English Cocker Spaniels were included in the study. Signalment, duration of clinical signs, and predominant clinical signs for dogs in this group are summarized **(Table 1)**. Spinal hyperesthesia was present in 78 dogs and was the predominant sign in 12. Neurologic deficits were reported for 68 dogs. Neurologic grades of 0 (n = 9 dogs), 1 (3), 2 (12), 3 (20), 4 (17), and 5 (20) were recorded.

Of 39 English Cocker Spaniels that received medical treatment before referral, including NSAIDs (n = 30), dexamethasone (1), or a combination of NSAIDs and opioids (8), clinical status had improved in 2 dogs prior to evaluation at the study facility. Diagnosis of IVDE was made on the basis of MRI findings for 60 dogs, myelography of the lumbar region of the spinal cord for 11 dogs, and CT for 10 dogs. The IVDEs were in the thoracolumbar region in 36 of 81 (44%) dogs, the midlumbar region in 24 of 81 (30%), and the cau-

Table 1—Comparison of variables of interest in a retrospective study of 81 English Cocker Spaniels and 81 Dachshunds with thoracolumbar or lumbar IVDEs.

Variable	English Cocker Spaniels (n = 81)	Dachshunds (n = 81)	*P* value
Male	51 (63)	46 (57)	0.52
Female	30 (37)	35 (43)	0.52
Neutered	65 (80)	65 (80)	NA
Age (y)	6.8 ± 2.7	5.6 ± 2.2	0.006
Duration of clinical signs (d)	2.0 (0.5–44)	2.0 (1–54)	0.15
Medical treatment before referral	39 (48)	44 (54)	0.53
Predominant clinical sign			
Spinal hyperesthesia	12 (15)	3 (4)	0.013
Unilateral pelvic limb lameness	9 (11)	1 (1)	0.013
Pelvic limb ataxia	2 (2)	4 (5)	0.51
Paraparesis			
Ambulatory	14 (17)	23 (28)	0.21
Nonambulatory	19 (23)	24 (30)	0.48
Paraplegia	25 (31)	26 (32)	0.52
Neurologic grade	3 (0–5)	3 (0–5)	0.43
Neurologic deficits present	68 (84)	79 (98)	0.029
IDVE location*			
Thoracolumbar	36 (44)	67 (83)	0.005
Midlumbar	24 (30)	13 (16)	0.009
Caudal lumbar	21 (26)	1 (1)	0.001

Values are number of dogs (%), mean ± SD, or median (range). Values of $P < 0.05$ were considered significant.

*Regions for IVDEs were designated as the thoracolumbar (T9-10 to L1-2 IVDSs), midlumbar (L2-3 to L4-5 IVDSs), or caudal lumbar (L5-6 to L7-S1 IVDSs) vertebral column.

NA = Not applicable.

dal lumbar region in 21 (26%) dogs **(Figure 1)**. One dog had 2 caudal lumbar region IVDEs. The T13-L1 IVDS was most often affected (n = 16), followed by T12-13 (14), L3-4 and L6-7 (11 each), L2-3 (8), L5-6 (7), L4-5 (5), T11-12 and L7-S1 (4 each), and T10-11 and L1-2 (1 each). In the dog with 2 concurrent IVDEs, the L6-7 and L7-S1 IVDSs were affected. In 47 of 47 English Cocker Spaniels with thoracolumbar or midlumbar region IVDEs that underwent MRI, the lesion was seen on sagittal images. In 4 of 13 dogs with caudal lumbar IVDE that underwent MRI, the lesion was not immediately seen on midsagittal or sagittal images, but was detected on transverse images **(Figure 2)**.

Most dogs (71/81 [88%]) underwent surgical treatment. The diagnosis of IVDE was confirmed during surgery in all 71 of these dogs. In 4 dogs with caudal lumbar region IVDE, surgery was complicated by thickening of the spinal nerve and adhesions between neural and surrounding epidural tissues. Three surgically treated dogs with thoracolumbar region IVDE were euthanized during hospitalization because of lack of improvement. Mean postoperative hospitalization for the remaining 68 dogs was 7.2 ± 4.7 days (range, 1 to 20 days). At the time of discharge, 62 of these 68 (91%) surgical patients were ambulatory **(Table 2)**. All medically managed dogs (n = 8) were ambulatory at discharge, with a mean duration of hospitalization of 2.5 ± 1.1 days.

One dog that had surgical treatment of a thoracolumbar region IVDE was euthanized within 2 weeks after discharge from the hospital because of lack of improvement. Sixty-three of the remaining 75 dogs (55 surgically and 8 medically treated) had short-term follow-up data available. Fifty of 55 (91%) surgically treated dogs were ambulatory, and 9 of 55 (16%) were considered neurologically normal (Table 2). All 8 medically managed dogs were ambulatory, with 1 considered to be neurologically normal at the time of the last follow-up examination. Long-term follow-up information was available for 54 of 76 (71%) dogs that had survived to hospital discharge; follow-up times ranged from 5 months to 9 years and 5 months (median, 2 years and 9 months). All 54 of these dogs had undergone surgical treatment. Information was obtained from the referring veterinarians (n = 20) or both the veterinarian and owner

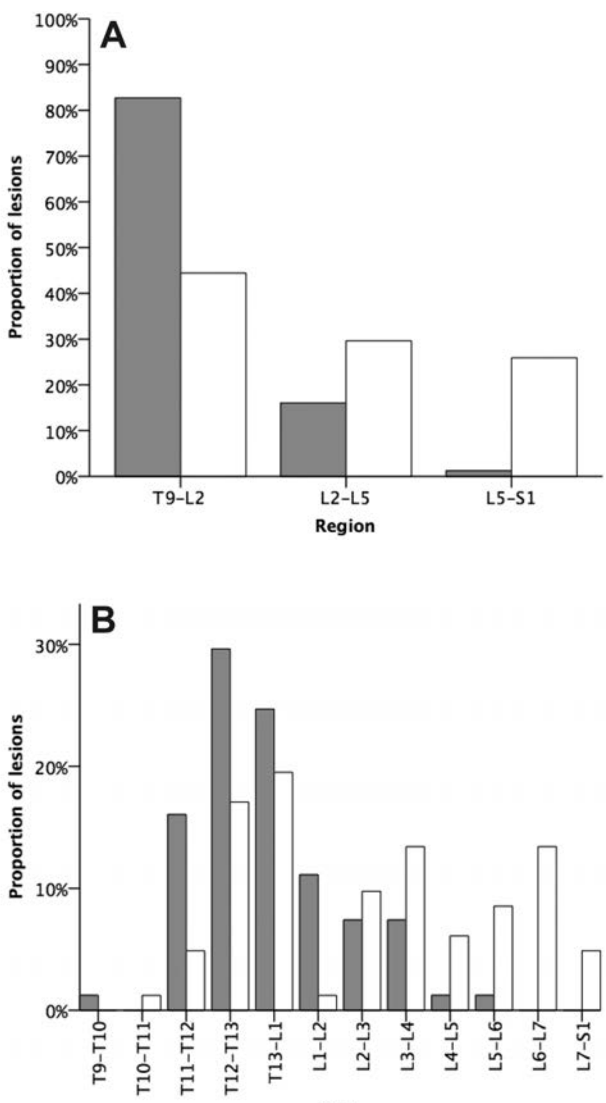

Figure 1—Anatomic distribution of affected IVDSs in 81 English Cocker Spaniels (white bars) and 81 Dachshunds (gray bars) with thoracolumbar or lumbar IVDEs. A—Affected IVDSs grouped by region of the vertebral column as thoracolumbar (T9-10 through L1-2), midlumbar (L2-3 through L4-5), or caudal lumbar (L5-6 through L7-S1). B—Distribution of affected IVDSs for the same dogs in panel A.

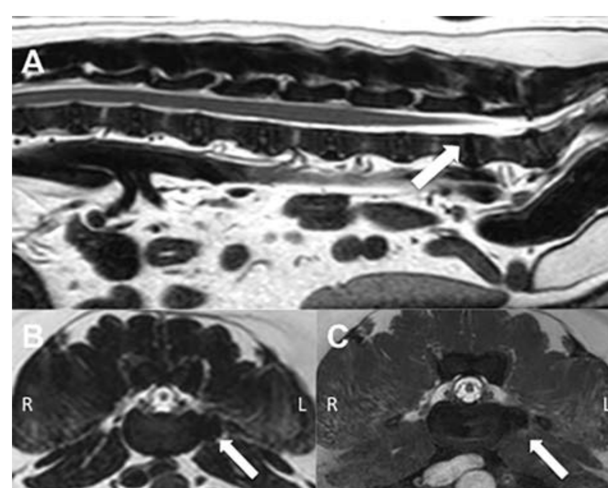

Figure 2—Sagittal (A) and transverse (B and C) MR images of an English Cocker Spaniel with an IVDE at the L6-7 IVDS. The T2-weighted sagittal image of the lumbar region in panel A does not reveal obvious spinal cord or cauda equina compression at the L6-7 IVDS (arrow); the T2-weighted and T1-weighted transverse images obtained at the level of the L6-7 IVDS in panels B and C, respectively, demonstrate a lateralized IVDE compressing the left spinal nerve ventral to the intervertebral foramen (arrow). L = Left. R = Right.

Table 2—Results of analyses to identify associations between location of affected IVDS and signalment, clinical signs, treatment, and outcome for 81 English Cocker Spaniels with thoracolumbar or lumbar IVDEs.

	Affected IDVS location		
Variable	**Thoracolumbar (n = 36)**	**Midlumbar (n = 24)**	**Caudal lumbar (n = 21)**
Male	23 (64)	15 (62)	13 (62)
Female	13 (36)	9 (38)	8 (38)
Neutered	26 (72)	19 (79)	20 (95)
Age (y)	6.9 ± 2.9	7.1 ± 2.6	6.2 ± 2.3
Weight (kg)	14.2 ± 3.3	13.2 ± 2.3	14.9 ± 3.0
Duration of clinical signs (d)	1 (0.5–7)[A]	2 (1–9)[a]	7 (1–44)[A,a]
Medical treatment prior to referral	12 (33)[a]	12 (50)	15 (71)[a]
Predominant clinical sign			
Spinal hyperesthesia	2 (6)[A]	2 (8)[B]	8 (38)[A,B]
Unilateral pelvic lameness	0 (0)[A]	1 (4)[B]	8 (38)[A,B]
Pelvic limb ataxia	2 (6)	0 (0)	0 (0)
Paraparesis			
Ambulatory	9 (25)[A]	5 (20.8)[B]	0[A,B]
Nonambulatory	7 (19)	8 (33)	4 (19)
Paraplegia	16 (44)[A]	8 (33)[B]	1 (5)[A,B]
Neurologic grade	3 (0–5)[A]	3 (0–5)[B]	5 (1–5)[A,B]
Neurologic deficits present	36 (100)[A]	23 (96)[B]	9 (43)[A,B]
Euthanasia without treatment	2 (6)	0	0
Medical treatment	2 (6)	0	6 (29)
Surgical treatment	32 (89)	24 (100)	15 (71)
Hospitalization (d)	8.3 ± 4.5[a]	7.5 ± 5.1[b]	4.2 ± 2.6[a,b]
Survived to discharge	29 (91)	24 (100)	15 (100)
Ambulatory at discharge	27 (87)	21 (88)	14 (93)
Days until ambulation	5.3 ± 4.6[A]	5.2 ± 4.6[a]	1.9 ± 1.2[A,a]
Short-term follow-up (reexamination)*	22 (71)	19 (79)	14 (93)
Ambulatory	20 (91)	17 (89)	13 (93)
Neurologically normal	2 (9)[a]	3 (16)[b]	4 (29)[a,b]
Long-term follow-up*	23 (74)	16 (67)	15 (100)
Neurologically normal	4 (17)	4 (25)	8 (53)
Improved	15 (65)	12 (75)	6 (40)
No improvement or worse	4 (17)	0 (0)	1 (7)

Values are number (%), mean ± SD, or median (range) for the group or subgroup of dogs shown.
*Percentages based on the number of surviving dogs.
[a,b]Within a row, values with the same superscript lowercase letters differ significantly ($P < 0.05$). [A,B]Within a row, values with the same superscript uppercase letters differ significantly ($P < 0.005$).

(34). Forty-nine of these 54 (91%) dogs had a successful outcome and were considered to be neurologically normal (n = 16) or improved (33) with minimal residual deficits. The other 5 (9%) dogs had an unsuccessful outcome, with 1 euthanized because of a suspected recurrence of thoracolumbar IVDE.

Dachshunds

Eighty-one Dachshunds were enrolled in the study. These dogs were included for purposes of comparison of signalment, clinical signs, neurologic status, and IVDE location with those of English Cocker Spaniels (Table 1). Spinal hyperesthesia was detected in 75 dogs and was the predominant clinical sign for 3. Neurologic deficits were reported for 79 dogs. Neurologic grades for Dachshunds included 0 (n = 9), 1 (1), 2 (14), 3 (26), 4 (28) and 5 (3). Diagnosis of IVDE was made on the basis of MRI results for 55 dogs, myelography of the lumbar region for 21 dogs, and CT for 5 dogs. The IVDEs were in the thoracolumbar region in 67 (83%) dogs, midlumbar region in 13 (16%) dogs, and the caudal lumbar region in 1 (1%) dog (Figure 1). The T12-13 IVDS was most often affected (n = 24), followed by T13-L1 (20), T11-12 (13), L1-2 (9), L2-3 and L3-4 (6 each), and T9-10, L4-5, and L5-6 (1 each).

Comparison between English Cocker Spaniels and Dachshunds

The mean age of English Cocker Spaniels was significantly greater (by approx 14 months) than that of Dachshunds at the time of referral evaluation and diagnosis of IVDE. English Cocker Spaniels had spinal hyperesthesia or unilateral pelvic limb lameness as the predominant clinical sign more frequently than did Dachshunds. A greater proportion of Dachshunds had neurologic deficits, compared with English Cocker Spaniels (Table 1).

English Cocker Spaniels had greater odds of having midlumbar (OR, 4.4; 95% confidence interval, 1.9 to 10.4; $P = 0.001$) and caudal lumbar (OR, 35.5; 95% confidence interval, 3.3 to 374.4; $P = 0.003$) IVDEs than did Dachshunds, whereas Dachshunds had greater odds of having thoracolumbar IVDEs (OR, 16.2; 95% confidence interval, 3.8 to 30.7; $P = 0.01$). More specifically, Dachshunds more frequently had T11-12 ($P = 0.007$) and L1-2 ($P = 0.009$) IVDEs, compared with English Cocker Spaniels, and English Cocker Spaniels more often had L5-6 ($P = 0.017$), L6-7 ($P = 0.001$), and L7-S1 ($P = 0.005$) IVDEs (Figure 1). There were no significant differences in sex, neuter status, or median neurologic grade between breeds.

Associations of IVDE location with signalment and clinical signs in English Cocker Spaniels

There was no significant association of IVDE location with sex, age, neuter status, or body weight. English Cocker Spaniels with caudal lumbar IVDE had a significantly greater duration of clinical signs prior to referral evaluation, more frequently had spinal hyperesthesia or unilateral pelvic limb lameness as the predominant clinical sign, and had a higher (less severe) median neurologic grade, compared with those that had thoracolumbar or midlumbar IVDEs (Table 2).

A greater proportion of English Cocker Spaniels with caudal lumbar IVDE had undergone medical management before referral, compared with those that had thoracolumbar IVDE (Table 2). All 36 (100%) English Cocker Spaniels with thoracolumbar IVDE had neurologic deficits. Twenty-three of the 24 (96%) dogs with midlumbar IVDE had neurologic deficits detected, and decreased spinal reflexes were evident in 12 of 24 (50%). Only 9 of 21 (43%) English Cocker Spaniels with caudal lumbar IVDE had neurologic deficits, and decreased spinal reflexes were reported for 7 of 21 (33%); the proportion of these dogs with neurologic deficits was significantly smaller than those of dogs with thoracolumbar or midlumbar IVDE.

Association of IVDE location with outcome in English Cocker Spaniels

Dogs of this breed with caudal lumbar IVDE had a shorter mean duration of hospitalization and a significantly shorter mean number of days to become ambulatory after surgery than did those with thoracolumbar or midlumbar IVDE (Table 2). For the 8 medically managed dogs, there was no significant association of IVDE location with hospitalization time. English Cocker Spaniels with caudal lumbar IVDE (4/14) were more likely to be neurologically normal than dogs with thoracolumbar (2/22; $P = 0.007$) or midlumbar (3/19; $P = 0.04$) IVDE on short-term follow-up (reexamination) visits after surgery. There was no significant influence of IVDE location on any measures of long-term outcome.

Discussion

In the present study, characteristics of thoracolumbar (T9-10 through L1-2), midlumbar (L2-3 through L4-5), and caudal lumbar (L5-6 through L7-S1) IVDE in English Cocker Spaniels were investigated. We compared the signalment, clinical signs, neurologic evaluation results, and anatomic distribution of IVDEs between Dachshunds and English Cocker Spaniels and evaluated associations between the affected IVDS location and selected characteristics (signalment, clinical signs, neurologic grade, presence of neurologic deficits, and outcomes such as hospitalization time, time to ambulation after surgery, and neurologic status at short- and long-term follow-up after surgery) for English Cocker Spaniels. The results of this study suggested that English Cocker Spaniels have a different distribution of IVDE along the vertebral column, compared with Dachshunds, and that this finding is of potential clinical importance in English Cocker Spaniels.

The ages, clinical signs, and locations of affected IVDSs of Dachshunds in our study were similar to those reported previously.[2,20,21] The IVDSs between T9 and L2 were affected in 67 of 81 (83%) of Dachshunds, whereas this region was affected by IVDE in only 36 of 81 (44%) English Cocker Spaniels. Although thoracolumbar IVDSs were still most often affected, caudal lumbar IVDE was significantly more common in English Cocker Spaniels than in Dachshunds (21/81 [26%] vs 1/81 [1%]). Although this discrepancy in distribution is difficult to explain, differences in body conformation and spinal biomechanics could contribute to this finding. The etiology of intervertebral disk disease is considered to be multifactorial with genetic, biomechanical, and anatomic factors involved.[22] Several genes have been suggested to have roles in the etiology of intervertebral disk disease, and some of these genes are associated with chondrodystrophy.[23–25] Chondrodystrophy is characterized by disturbed endochondral ossification, so that affected dogs have disproportionally short limbs and relatively long spines.[5,22,26] This was highlighted in a recent study,[5] in which investigators found that dogs with shorter limbs and longer backs were at increased risk of developing thoracolumbar IVDE than were dogs with longer limbs and shorter backs. However, strict criteria to define a breed as chondrodystrophic are lacking,[1,9,27] and it is currently unclear whether English Cocker Spaniels should be considered chondrodystrophic.[1–4,6,12,13,22,27,28] It has been demonstrated that English Cocker Spaniels have a less pronounced chondrodystrophic phenotype than Dachshunds.[5] The vertebral column length relative to the height at the withers (most dorsal aspect of the shoulders between the scapulae) was much higher in Dachshunds than in English Cocker Spaniels, but was similar between English Cocker Spaniels and German Shepherd Dogs.[5] It is therefore possible that different etiologic factors contribute to varying degrees in the development of IVDE in English Cocker Spaniels and Dachshunds.

The difference in anatomic distribution of IVDEs in English Cocker Spaniels, compared with that of Dachshunds, is of potential clinical importance. On the basis of our study results, affected English Cocker Spaniels could be divided into 2 clinical phenotypes: those with either thoracolumbar or midlumbar IVDE and those with caudal lumbar IVDE. English Cocker Spaniels with thoracolumbar and midlumbar IVDE comprised the majority (60/81 [74%]) of cases for this breed and had clinical signs and neurologic examination findings similar to those for the group of Dachshunds. They more commonly had acute onset of clinical signs, presence of neurologic deficits, and paraplegia or ambulatory paraparesis as the predominant clinical sign at referral than did dogs of the same breed with caudal lumbar IVDE. They had good outcomes after surgery, similar to previous reports[3,4,8,10,13] of other breeds with thoracolumbar IVDE.

English Cocker Spaniels with caudal lumbar IVDE less frequently had neurologic deficits on initial evaluation, more commonly had spinal hyperesthesia or unilateral pelvic limb lameness as a predominant clinical sign, and had a longer median duration of clinical signs before evaluation, compared with dogs of the same breed that had thoracolumbar or midlumbar IVDE (Table 2). Dogs with caudal lumbar IVDE also had more commonly received medical treatment before referral than did those with thoracolumbar IVDE. It is possible this group of dogs had a more chronic clinical presentation because the predominant clinical signs (hyperesthesia or lameness), in combination with unremarkable neurologic examination results, can be difficult to differentiate from a primary orthopedic problem. In this study, only 7 of 21 (33%) English Cocker Spaniels with caudal lumbar IVDE had decreased spinal reflexes, suggestive for a lower motor neuron lesion. This was in contrast to results of another study,[29] in which decreased spinal reflexes were found in 21 of 36 (58%) dogs of a variation of breeds with caudal lumbar IVDE. This difference can probably be explained by different definitions of caudal lumbar IVDE in the 2 studies. Whereas caudal lumbar IVDSs were defined as the L5-6 through L7-S1 in the present study, these were defined as between L3-L4 and L6-L7 by Dhupa et al.[29] Thirty-three of 36 (92%) dogs in that study[29] had IVDE at the L3-4 or L4-5 IVDS, which would have been classified as part of the midlumbar region in the study reported here. An IVDE at this location can potentially cause dysfunction of the lumbosacral intumescence[30] It is not surprising that most English Cocker Spaniels in our study with IVDE between the L5-L6 and L7-S1 IVDSs did not have decreased spinal reflexes or other neurologic deficits. Extruded disk material at this location typically results in cauda equina compression instead of spinal cord compression.[30] Unilateral pelvic limb lameness, referred to as nerve root signature, without neurologic deficits is a common clinical presentation of dogs with cauda equina compression resulting from degenerative lumbosacral stenosis.[19] It is of note that in a proportion of English Cocker Spaniels with caudal lumbar IVDE, surgery was complicated by thickening of the spinal nerve and adhesions with surrounding tissues. This illustrates that, despite the lack of neurologic dysfunction, lameness caused by caudal lumbar IVDE should not be considered a benign condition. Delaying an accurate diagnosis can initiate a cascade of morphological changes of the compressed spinal nerves and surrounding tissues. Extruded disk material initiates an inflammatory cascade within the vertebral canal, leading to upregulation of inflammatory markers, proliferation of soft tissues, and disturbances of CSF flow and vascular drainage of nerve roots and dorsal root ganglia, which can result in intraradicular edema formation.[31–33] Compressed nerves further thicken owing to progressive fibrotic hypertrophy with Renaut body formation.[33,e] These changes can initiate a self-perpetuating cascade, causing progressive spinal nerve compression and ultimately resulting in chronic hyperesthesia poorly responsive to conventional analgesics.[34,35,f] Making a diagnosis of caudal lumbar IVDE was further complicated by the difficulty of recognizing lateralized disk extrusions on sagittal MR images. In a proportion of English Cocker Spaniels with caudal lumbar IVDE, extruded disk material was only clearly identified after inspection of the transverse images. It is therefore possible that caudal lumbar IVDE in English Cocker Spaniels is currently underrecognized, and the results of the present study may help to raise the awareness of the potential for caudal lumbar IVDE in this specific breed. English Cocker Spaniels with this condition improved remarkably well after surgery; they had shorter hospitalization times, required less time to become ambulatory after surgery, and were more often neurologically normal at the reexamination visits than were English Cocker Spaniels with thoracolumbar and midlumbar IVDE. These postoperative recovery characteristics further highlight the importance of reaching an accurate diagnosis of caudal lumbar IVDE in English Cocker Spaniels with clinical signs suggestive of the condition.

The present study was limited by its retrospective nature, which complicated standardized assessment of included dogs. Only a small proportion of dogs were treated medically, and all dogs were patients referred to the University of London Royal Veterinary College Small Animal Referral Hospital, which could have resulted in bias toward more severely affected patients. It is therefore possible that our findings are not directly applicable to the overall population of English Cocker Spaniels with thoracolumbar or lumbar IVDE, and further clinical study should be performed to evaluate this.

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Footnotes

a. Omnipaque, 240 mg of organic iodine/mL, GE Healthcare, Diegem, Belgium.
b. 16-slice helical CT scanner, PQ 500, Universal Systems, Solon, Ohio.
c. Intera 1.5T, Philips Medical Systems, Eindhoven, The Netherlands.
d. SPSS, version 21.0.1, SPSS Inc, Chicago, Ill.
e. Foitzik U, Godde T, Rosati M, et al. Neuronal versus interstitial and vascular changes in dorsal root ganglia (DRG) of entrapped nerve roots: impacts on pathophysiology (abstr), in *Proceedings*, 27th Symp Eur Coll Vet Neurol 2014.
f. Foitzik U, Godde T, Rosati M, Steffen F, Volk HA, Flegel T, et al. Selective vulnerability of individual nerve root sub-segments to compression radiculopathy in dogs (abstr), in *Proceedings*. 27th Symp Eur Coll Vet Neurol 2014.

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Correction: Pathology in Practice: canine distemper virus infection in a puppy

In the Pathology in Practice report describing canine distemper virus (CDV) infection in a puppy (*J Am Vet Med Assoc* 2015;247:1375–1377), the sentence at the end of the first paragraph in the Comments section lists cheetahs as one of the many varieties of carnivores susceptible to CDV infection. However, it is not clear that cheetahs are in fact susceptible. For example, Appel et al[1] tested serum samples collected from 65 cheetahs between 1985 and 1993 at the National Zoo in Washington, DC, for antibodies against CDV, and results were negative for all 65. Munson et al[2] identified anti-CDV antibodies in serum samples from wild Namibian cheetahs; however, clinical disease was not documented, and the Association of Zoos and Aquariums Species Survival Plan does not currently recommend vaccinating cheetahs against CDV.

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