Epidemiology of cranial cruciate ligament disease diagnosis in dogs attending primary-care veterinary practices in England

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Abstract

Objective: Estimate prevalence and risk factors for cranial cruciate ligament (CCL) disease diagnosis in dogs and describe management of cases attending primary-care veterinary practices.

Study design: Historical cohort with a nested case-control study.

Sample population: 953 dogs diagnosed with CCL disease from 171,522 dogs attending 97 primary-care practices in England.

Methods: Medical records of dogs attending practices participating in the VetCompass project that met selection criteria were assessed. Univariable and multivariable logistic regression methods evaluated association of risk factors with CCL disease diagnosis.

Results: CCL disease prevalence was estimated at 0.56% (95% CI: 0.52 – 0.59). Compared with crossbred dogs, rottweilers, west highland white terriers, golden retrievers, Yorkshire terriers, and Staffordshire bull terriers showed increased odds of CCL disease diagnosis whilst cocker spaniels showed reduced odds. Increasing bodyweight within breeds was associated with increased odds of diagnosis. Dogs aged over 3 years had increased odds of diagnosis compared with dogs aged less than 3 years. Neutered females had 2.1 times the odds of diagnosis compared with entire females. Insured dogs had 4 times the odds of diagnosis compared with uninsured dogs. Two thirds of cases were managed surgically; insured and heavier dogs more frequently had surgery. Overall, 21% of cases were referred, with referral more frequent in heavier and insured dogs. Referred dogs more frequently had surgery and an osteotomy procedure.

Conclusion: Breed predispositions and demographic factors associated with diagnosis and case management of CCL disease in dogs identified in this study can be used to help direct future research and management strategies.

Introduction

Disease of the cranial cruciate ligament (CCL) is one of the most common causes of pelvic limb lameness in the dog.[1] CCL insufficiency renders the stifle joint unstable and predisposes to degenerative joint disease. In rare circumstances there can be acute traumatic rupture of the CCL, however the majority of CCL ruptures are characterised by a gradual degeneration of the extracellular matrix (ECM), leading to ligament rupture.[2] The underlying aetiopathegenesis of this degenerative disease process remains unclear and is considered to be complex and multifactorial.[3] Previous studies have reported prevalence estimates for CCL disease in dogs from 1.2-2.6% and identified risk factors including breed, sex, neutering, age and bodyweight.[4-8] A study of 1.25 million dogs in the USA from a predominantly referral population over a 40-year period identified the 5 breeds most commonly affected as the Newfoundland, rottweiler, Labrador retriever, bulldog and boxer.[4] Subsequent studies have confirmed increased prevalence in the Labrador retriever, Newfoundland, boxer and rottweiler as well as reporting predispositions in other breeds including the west highland white terrier, Yorkshire terrier, golden retriever, Staffordshire bull terrier, Neapolitan mastiff, akita, saint bernard, mastiff, Chesapeake bay retriever and American Staffordshire terrier.[5-8]

Female dogs have been reported to be more frequently diagnosed with CCL disease compared to male dogs, while neutered dogs are at a greater risk than entire dogs.[4, 9-10] When considering age as a risk factor for CCL disease diagnosis, Witsberger[4] and others reported that dogs older than 4 years of age were significantly more likely to be affected. Other studies have further shown that large breeds are diagnosed with CCL disease at a younger age than small breeds.[7,8,11,12] Bodyweight has also been identified as a risk factor with heavier dogs, as well as those dogs considered to be overweight, being more likely to be diagnosed with CCL disease.[7,8,13]

Many CCL disease studies have been based on referral populations or relatively small populations of dogs and may therefore be less representative of the overall caseload seen in primary-care practice.[14] Referral caseloads may also show selection bias towards more complicated disorders.[17] Systematic collection and analysis of the VetCompass merged database of primary-care practice data offer an opportunity to characterise the CCL disease caseload recorded in primary-care practice in England.[15,16] Compared with questionnaire-based studies, access to clinical data recorded at the time of the health event and that covers all animals attending the participating veterinary practices should reduce selection and recall biases for studies using electronic patient records.[15]

This study aimed to estimate the prevalence of CCL disease diagnosed in dogs attending primary-care veterinary practices in England. The study objectives included evaluation of purebred status, breed, sex, bodyweight, age and insurance status, as risk factors for the diagnosis of CCL disease and to describe the management of affected dogs. It was hypothesised that increased bodyweight in dogs is associated with increased risk of diagnosis with CCL disease.

Materials and methods

Ethics statement: Ethics approval was granted by the RVC Ethics and Welfare Committee (reference number 2010 1076F).

The VetCompass animal surveillance project collates de-identified electronic patient record data from primary-care veterinary practices in the UK for epidemiological research.[20] The sampling frame for the current study included electronic patient record data relating to all dogs provided with health care during the study period at every clinic within the Medivet Veterinary Group, a large network of integrated veterinary practices covering central and south-eastern England.[21] These clinics care predominantly for companion animal species and were located within both urban and rural locations. Clinical data shared with VetCompass are de-identified and participation within VetCompass operates under an opt-out approach for owner consent.[22] Participating practices used a single bespoke practice management system that allowed practitioners to record summary diagnosis terms from an embedded standard nomenclature, the VeNom codes,[23] at episodes of clinical care. Electronic patient record data were extracted from the practice management system using integrated clinical queries[24] and uploaded to a secure structured query language database. Information collected included patient demographic (animal identification number, species, breed, date of birth, sex, neuter status, insurance status, microchip number and bodyweight) and clinical information (free-form text clinical notes, VeNom summary diagnosis terms and treatment, with relevant dates).

The study used a historical cohort design for prevalence estimation with a nested case-control design for risk factor analysis. The study sampling frame included all dogs with at least one electronic patient record (clinical note, bodyweight recording or treatment dispensed) recorded within the VetCompass Animal Surveillance database from September 1st, 2009 to July 7th, 2013.

Sample size calculations[25] estimated an unmatched case-control study with 974 cases and 1,948 controls would have an 80% power to detect a risk factor with an odds ratio of 1.4 or greater (two-sided α = .05) and a 10% prevalence in the control animals.

Potential CCL disease cases were identified by searching the clinical free text and VeNom Code fields using multiple search terms: *cruciat*, *ccl*, *cranial draw*, *acl*, *tta*, *tplo*, *lateral sut*, *extracapsular sut* and *de ang*. Dogs identified from each search term were aggregated and duplicates removed. The full clinical notes recorded during the study period for each identified dog were reviewed in detail. The case definition for a case diagnosed with CCL disease required that the dog presented with a pelvic limb lameness plus one of a) ipsilateral cranial drawer or tibial thrust; b) CCL disease confirmed at surgery; or c) MRI/CT/ultrasound findings compatible with CCL disease, leading to a final diagnosis by the attending veterinarian of the existence of CCL disease.

For dogs that met the case definition, further data extraction described the case as incident or pre-existing, date of diagnosis (for incident cases), type and date of any surgery performed (osteotomy, extra-capsular, intra-capsular) and whether the case was referred for secondary-care treatment. Control dogs for the case-control analysis were randomly selected from the overall study population using a web-based random number generator[26] with exclusion of dogs with a clinical history suggestive of possible CCL disease.

Recognisable single breeds[27] were grouped as ‘purebred’ and all other dogs were grouped as ‘crossbred’. Individual breeds with 50 or more dogs in the nested case-control study were listed as ‘frequent breeds’ and included separately in the analyses. Neuter status was defined by the final electronic patient record neuter value and combined with sex to create 4 categories: female entire, female neutered, male entire and male neutered. Insurance and microchip status characterised the existence of a positive status at any time during the study period. The maximum bodyweight (kg) recorded for dogs aged over 1 year was extracted and categorised across all dogs (< 10.0, 10.0-19.9, 20.0-29.9, 30.0-39.9, ≥ 40.0, 'no recorded bodyweight') and also as tertiles within the frequent breeds (high, mid, low, 'no recorded bodyweight') to allow the effect of variation of body weight *within* these breeds to be assessed. Age (years) at a randomly selected episode of care during the study period was calculated for the case and control animals and was categorised into 5 groups (< 3.0, 3.0-5.99, 6.0-8.99, 9.0-11.99, ≥ 12.0).

Study data were exported from the VetCompass database to a spreadsheet (Microsoft Office Excel 2007, Microsoft Corp.) for checking and cleaning before further export to Stata Version 11.2 (Stata Corporation) for statistical analyses. The prevalence of CCL disease was estimated, with 95% confidence interval (CI) based on approximation to the normal distribution.[28] Demographic results were reported for the case and control dogs. Exploratory evaluation of statistical associations between a range of categorical variables (purebred, breed, sex/neuter, insurance, age group, bodyweight tertile, surgery performed, surgery type) used the chi-squared (or Fisher's exact test if the expected counts were fewer than 10 in any cell).[28] Risk factor analysis firstly screened all demographic risk factors using univariable logistic regression; factors with a liberal $P<.20$ were further evaluated using multivariable logistic regression. Model-building used manual backwards elimination, beginning with the maximum model and iteratively testing and eliminating variables using a cut-off of $P<.05$. All eliminated factors were re-evaluated for confounding effects within the provisional-final model using the change-in-estimate approach: a change in the odds ratio for a primary exposure variable of more than 10% was considered to represent important confounding.[29,30] Biologically important pairwise interactions between final model variables were assessed using the likelihood ratio test with a cut-off of $P<.05$.[29] Clustering in the final model was evaluated using the clinic attended as a random effect to compare the results from mixed-effects logistic regression modelling with standard logistic regression modelling.[29] Model-fit was evaluated using the Hosmer Lemeshow goodness-of-fit test statistic and the area under the ROC curve.[29,31] Statistical significance was set at *P*=.05. The results from the logistic regression modelling are reported as odds ratio which express the relative strength of association between the risk factor and the outcome of diagnosis with CCL disease.[32]

Results

The study population comprised 171,522 dogs attending 97 clinics across central and south-eastern England. From these, 953 cases diagnosed with CCL disease were identified, yielding an apparent prevalence of 0.56% (95% CI: 0.52 – 0.59). This period prevalence value was based on an open cohort of dogs with a median study time per dog of 2.1 years (IQR: 1.0 – 2.7, range; 0.0 – 3.8). Risk factor analysis included 953 cases and 1,875 control dogs attending 91 clinics. Overall data completeness varied between the variables: breed 100%, sex 100%, neutered status 100%, insured status 100%, bodyweight 73% and age 94%. Of the dogs diagnosed with CCL disease with information available, 765/953 (80%) were purebred, 492/953 (52%) were female, 686/953 (72%) were neutered, 502/953 (53%) were insured and 354/953 (37%) were microchipped. Median bodyweight was 25 kg (IQR: 12.0 – 36.4, range: 2.6 – 77.0) and the median age was 7.4 years (IQR: 4.7-10.0, range: 0.26 – 16.3). The most frequent 11 breeds accounted for 503 (53%) of the case dogs.

Of the control dogs with information available, 1,470/1875 (78%) were purebred, 887/1875 (48%) were female, 657/1875 (35%) were neutered, 298/1875 (16%) were insured and 502/1875 (27%) were microchipped. Median bodyweight was 17 kg (IQR: 8.8 – 28.5, range: 1.6 – 73.9) and the median age was 4 years (IQR: 1.2 – 8.0, range: 0.0 – 20.0). The most frequent 11 breeds accounted for 830/1875 (44%) of the control dogs.

The 953 case dogs comprised 621 (65%) incident cases that were diagnosed for the first time during the study period and 332 (35%) cases that had been diagnosed with CCL disease prior to the study period. The median age at first diagnosis of incident cases was 7 years (IQR: 4.2 – 9.6, range: 0.3 – 15.5) (Fig 1). Of the incident cases with information available, 423 (68%) were surgically managed, of which 209 (49.4%) underwent extra-capsular techniques and 214 (51%)

underwent osteotomy procedures. Of the incident cases, 129 (21%) were referred for specialist management, with insured (Fisher's exact test *P*=.003) and higher bodyweight (chi-squared *P*<.001) dogs more frequently referred. Referred dogs more frequently had surgery (Fisher's exact test *P*<.001) and an osteotomy procedure (chi-squared *P*<.001) than dogs managed in primary-care practice (Table 1). The probability of surgery was higher in insured (80%) than uninsured (55%) dogs (chi-squared *P*<.001) and increased with bodyweight (surgery - < 10.0 kg: 56%, 10.0-19.9: 63%, 20.0-29.9: 70%, 30.0-39.9: 75% and ≥ 40.0: 86%) (chi-squared *P*<.001). Compared with extra-capsular repair, osteotomy surgery was more frequent in insured (56%) than uninsured (41%) dogs (chi-squared *P*<.001) and increased as bodyweight increased (osteotomy - < 10.0 kg: 14%, 10.0-19.9: 34%, 20.0-29.9: 47%, 30.0-39.9: 65% and ≥ 40.0: 83%) (chi-squared *P*<.001). Younger dogs more frequently had surgery (surgery < 3.0 years: 78%, 3.0-5.99 years: 73%, 6.0-8.99 years: 70%, 9.0-11.99 years: 69%, ≥ 12.0 years: 20%) (chi-squared *P*<.001). Within age-bands of operated dogs, osteotomy was less frequent than extra-capsular repair as dogs aged: (extra-capsular versus osteotomy < 3.0 years: 26% vs 74%, 3.0-5.99 years: 42% vs 58%, 6.0-8.99 years: 51% vs 49%, 9.0-11.99 years: 72% vs 28%, ≥ 12.0 years: 80% vs 20%) (chi-squared *P*<.001).

Univariable logistic regression modelling identified 8 statistically significant variables (*P*<.20): purebred status, frequent breeds, bodyweight overall, bodyweight categories within frequent breeds, age, sex/neuter status, insurance status and microchip. Following evaluation using multivariable regression, the final model comprised 5 statistical significant risk factors: frequent breeds, bodyweight categories within frequent breeds, age, sex/neuter status and insurance status. Bodyweight overall was removed from the final model because bodyweight and breed are intrinsically related. No biologically-significant interactions were identified. The final nonclustered model showed acceptable model-fit (Hosmer-Lemeshow test result: *P*=.391) and discrimination (area under the ROC curve: .8235). The final model was improved by inclusion of the clinic attended as a random effect (*P*=.004, rho =0.03 indicating that 3% of variation was accounted for by the clinic attended). After accounting for the effects of the other variables (bodyweight categories within frequent breeds, age, sex/neuter status and insurance status) evaluated, 5 of the frequent breeds showed increased odds of a diagnosis of CCL disease compared with crossbreds: rottweiler (OR: 5.4, CI:2.6-11), west highland white terrier (OR: 2.5,CI: 1.5-4.2), golden retriever (OR: 1.9, CI:1.1-3.3), Yorkshire terrier (OR: 1.8, CI:1.0-3.0) and Staffordshire bull terrier (OR: 1.6, CI:1.0-2.5); and one of the frequent breeds showed decreased odds of diagnosis: cocker spaniel (OR: 0.4, CI:0.2-0.8). Increasing bodyweight within breeds was associated with increased odds of diagnosis with CCL disease; dogs categorised as high bodyweight within their breed had a 3.4 (*P*<.01) times odds of diagnosis compared to dogs categorised as low bodyweight. Dogs aged 9.0-11.9 years showed 4.4 (*P*<.001) times the odds of CCL diagnosis compared with dogs aged under 3 years. Neutered females had 2.1 (*P*<.001) times the odds of diagnosis compared with entire females. Insured dogs had 4.0 (*P*<.001) times the odds of diagnosis compared with uninsured dogs (Table 2).

Discussion

This study of dogs attending primary-care practices in England identified several breeds with increased odds of diagnosis with CCL disease compared with the remaining population of healthy and unwell dogs attending veterinary practices for any reason that did not have a diagnosis of CCL disease. The cocker spaniel had a significantly decreased odds of diagnosis. Neutered female dogs and dogs aged over 3 years had increased odds of diagnosis compared with dogs aged less than 3 years. Insured dogs were more likely to be diagnosed with CCL disease, and within breeds, heavier individuals were more likely to be diagnosed with CCL disease than lighter dogs.

The prevalence of CCL disease diagnosis reported in this study is lower than the previously reported range of 1.2%-2.6%.[4,6] This difference may be the result of previous studies estimating prevalence of CCL disease based on referral caseloads whilst the current study looked at CCL disease diagnosed in primary-care practice.

When considering specific breeds diagnosed with CCL disease, this study detected significantly increased odds of diagnosis with CCL disease in the rottweiler, west highland white terrier, golden retriever, Yorkshire terrier and Staffordshire bull terrier compared with crossbred dogs presenting to primary-care practices, and these findings are consistent with findings of other studies.[5-8] Identification of the cocker spaniel as a breed with reduced odds of diagnosis is a previously unreported finding and highlights a potential resource for further investigation. These findings may justify a morphometric analysis of breeds at increased and reduced risk, as has been reported for hip dysplasia.[33]

In support of the study hypothesis that increased bodyweight in dogs is associated with increased risk of diagnosis with CCL disease, the results showed a strong association between higher bodyweight within breeds and increased odds of CCL disease diagnosis. Because body size in an intrinsic descriptor for each breed, the study avoided conflating breed and body size effects by specifically comparing between bodyweight tertiles within breeds for associations with a diagnosis of CCL. Multivariable analysis demonstrated that bodyweight within breeds was significantly associated with CCL disease diagnosis. Within the frequent breeds in this study, dogs in the heaviest third of bodyweights had 3.4 times the odds of being diagnosed with CCL disease compared with those in the lightest third of bodyweights. Although the underlying reason for this is unclear, it is suggested that with increasing bodyweight, the load placed through the limbs and subsequent strain placed on the ligaments increases, which accelerates the process of degeneration of the CCL.[2,34] Without morphometric data, it is difficult to know whether those dogs in the heaviest bodyweight category had an increased stature compared to those in the lowest category or whether the dogs were overweight, however these data suggest that bodyweight plays a significant role in the development of CCL disease. Further investigation is required to understand the relative significance of bodyweight and obesity in the development of CCL disease.

The median age at first diagnosis of CCL disease was 7 years of age which parallels previous reports.[6,8] The finding that dogs aged 9.0-11.9 years had 4.4 times the odds of having a diagnosis compared with dogs aged under 3 years may result from increased ligament degeneration in older dogs compared to younger counterparts.[35]

Consistent with current published literature, female dogs and neutered dogs were at increased risk of being diagnosed with CCL disease.[4,7,8] Neutered female dogs had 2.1 times the odds of diagnosis compared with entire females. The underlying reason for this finding remains unclear but may be associated with increased obesity among neutered females[7,8] but a recent study of CCL disease in a UK population of dogs found no significant difference in body condition scores of neutered dogs compared with their entire counterparts in either the case or control groups.[6] It has also been suggested that hypoestrogenaemia associated with ovariohysterectomy may account for the increased incidence of CCL disease and oestrogen may confer a protective effect which is in contrast to findings in women.[2]

Insured dogs had 4 times the odds of diagnosis of CCL disease compared with uninsured dogs. This finding may reflect that owners of insured dogs are more willing to seek prompt evaluation and may reflect more thorough clinical investigation in insured dogs because financial constraints are less limiting and the owner's expectations are higher.[19] There may also be some degree of bias on the part of the veterinary surgeon – knowing the owners will want to pursue further investigation. Insured dogs were also more likely to undergo potentially more expensive options including surgery, referral for secondary-care management and osteotomy surgery rather than extra-capsular procedures. Full diagnosis of CCL disease in uninsured dogs may have been more difficult because primary-care practitioners were unable to establish the presence of cranial drawer or tibial thrust in the conscious dog and financial constraints prevented further investigation of the lameness.

Over two thirds of the dogs (68%) were managed surgically, with dogs referred for secondary-care treatment more frequently having a surgical intervention. Heavier dogs more frequently underwent surgery, which may be promoted by literature suggesting that dogs weighing greater than 15 kg show persistent lameness when not surgically managed.[36,37,39] Previous reports have also suggested that dogs weighing under 15 kg can do well with conservative management.[36,37] However these studies relied upon visual assessment of outcomes alone, and there is evidence that lameness detection in smaller dogs is more difficult due to more rapid stride frequency and shorter stride length leading to false assumption of greater improvement in small dogs than in larger dogs.[38] It appears that the notion that smaller dogs have less need of surgery for cruciate ligament disease persists today.

The current study identified a 50:50 split between extra-capsular and osteotomy techniques. A recent systematic review suggested that some osteotomy procedures offered a better outcome than extra-capsular methods, and it is perceived by many that osteotomy typically offers a more rapid early recovery than extra-capsular methods.[40-44] However, current best evidence, including force plate analysis, mostly indicate no significant long term difference in long-term limb function, or osteoarthritis progression between a well performed extra-capsular suture and an osteotomy procedure.[40-44]

Whilst the current study addressed many of selection and recall biases of previous epidemiological studies investigating canine CCL disease, it did still has limitations. The dogs studied attended a single large veterinary partnership group that may have a more consistent standard of care compared with the overall primary-care practices in England. Only dogs that attended veterinary practices were included in the study and thus the results may not necessarily generalise to the population of dogs that are not registered for veterinary care. It is worth noting, however, that the VetCompass programme shares clinical data on all dogs that attend primary-care veterinary practices and these include 24% of dogs with no disorders diagnosed.[45] The study relied on the attending veterinarians for diagnoses of CCL disease and it is possible that some truly affected dogs were missed or that some recorded CCL cases were misdiagnosed.

In conclusion, certain breeds appear at increased risk of CCL diagnosis, whilst the cocker spaniel had a reduced risk. Female neutered status, increased age and increasing bodyweight within breeds was identified as a risk factor for CCL disease diagnosis. Dogs that were insured were also more likely to be diagnosed with CCL disease. Most dogs were managed surgically as per current literature recommendations, and there was an even split extra-capsular and osteotomy techniques. Breed predispositions and demographic factors associated with diagnosis and case management of CCL disease in dogs identified in this study can be used to help direct future research and management strategies.

Disclosure Statement

The authors declare no conflict of interest.

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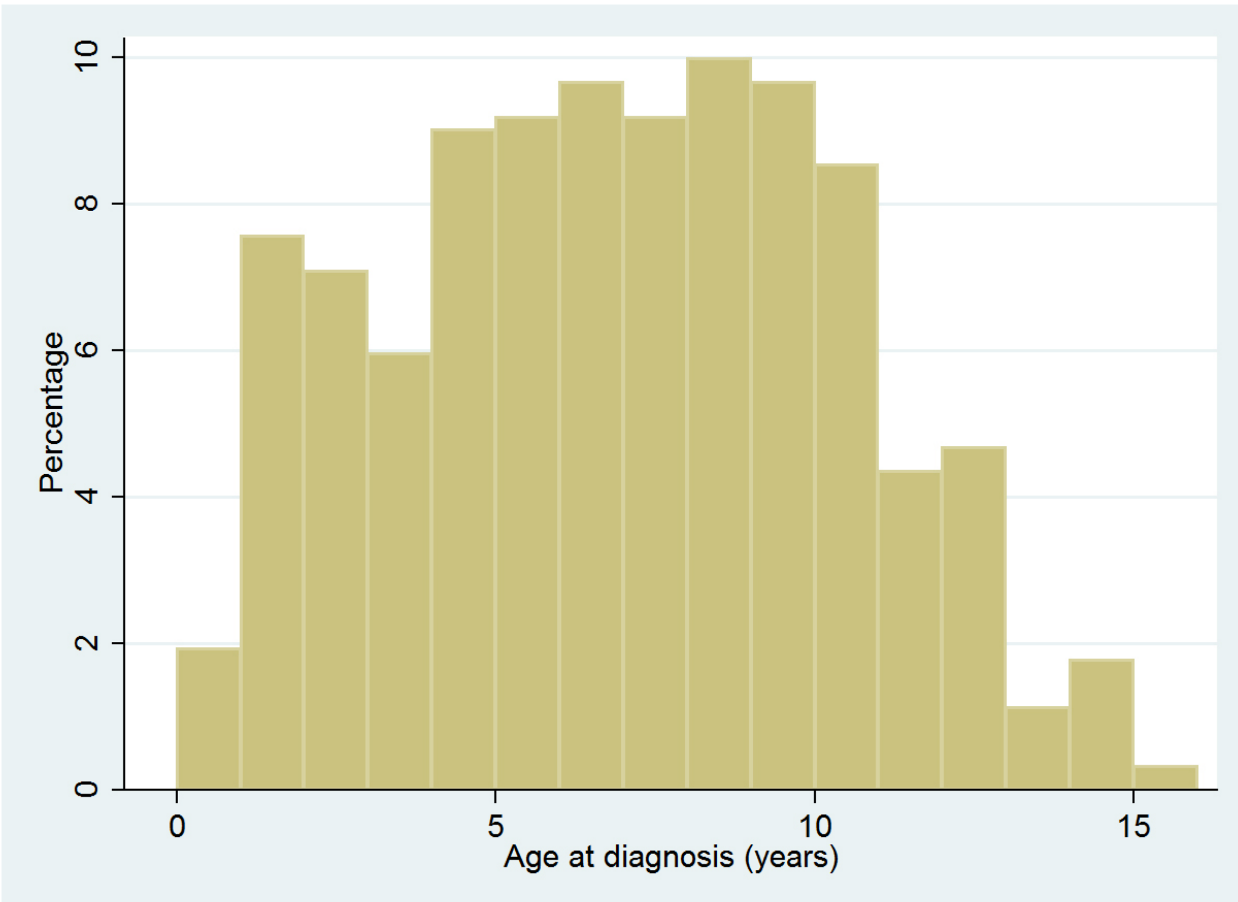
Figure 1: Age at diagnosis of cruciate disease in dogs (621 cases) attending primary-care veterinary practices in England



Tables

Table 1: Comparison between non-referred and referred dogs that had an incident diagnosis of cranial cruciate disease in a study of dogs attending primary-care veterinary practices in England.

Variable		Not referred No. (%)	Referred No. (%)	*P*-Value
Insurance	Non-insured	244 (84)	45 (16)	.003
	Insured	248 (75)	84 (25)	
Purebred status	Crossbred	112 (84)	22 (16)	.161
	Purebred	380 (78)	107 (22)	
Frequent breeds	Crossbreed	107 (85)	19 (15)	.254
	Rottweiler	17 (65)	9 (35)	
	West highland white terrier	44 (86)	8 (15)	
	Golden retriever	19 (76)	6 (24)	
	Yorkshire terrier	29 (88)	4 (12)	
	English springer spaniel	20 (83)	4 (17)	
	Staffordshire bull terrier	33 (83)	7 (18)	
	Jack Russell terrier	28 (85)	5 (15)	
	Labrador retriever	37 (69)	17 (32)	
	Other pure breeds	133 (76)	43 (24)	
	Border collie	6 (86)	1 (14)	
	German shepherd dog	9 (75)	3 (25)	
	Cocker spaniel	10 (77)	3 (23)	
Sex/neuter	Female entire	68 (86)	11 (14)	.181
	Female neutered	187 (75)	61 (25)	
	Male entire	66 (80)	17 (21)	
	Male neutered	171 (81)	40 (19)	
Bodyweight (kg)	< 10.0	100 (89)	13 (12)	< .001
	10.0-19.9	135 (84)	26 (16)	
	20.0-20.9	87 (82)	19 (18)	
	30.0-30.9	86 (72)	33 (28)	
	≥ 40.0	68 (65)	36 (35)	
	No recorded bodyweight	16 (89)	2 (11)	
Surgery	Surgery	294 (70)	129 (31)	< .001
	Not surgery	198 (100)	0 (0.0)	
Type of surgery	Extracapsular	177 (85)	32 (15)	< .001
	Osteotomy	117 (55)	97 (45)	

Table 2: Final multivariable logistic regression model for risk factors associated with cranial cruciate ligament disease in dogs attending primary-care veterinary practices in England.

Variable	**Category**	**Odds ratio**	**95% CI**	***P*-Value**
Frequent breeds	Crossbreed	Base		
	Rottweiler	5.4	2.6-11.0	< .001
	West highland white terrier	2.5	1.5-4.2	< .001
	Golden retriever	1.9	1.1-3.3	.017
	Yorkshire terrier	1.8	1.0-3.0	.039
	English springer spaniel	1.8	1.0-3.4	.051
	Staffordshire bull terrier	1.6	1.0-2.5	.042
	Jack Russell terrier	1.0	0.6-1.5	.909
	Labrador retriever	0.9	0.6-1.3	.478
	Other pure breeds	0.9	0.7-1.2	.377
	Border collie	0.5	0.3-1.1	.110
	German shepherd dog	0.6	0.3-1.2	.135
	Cocker spaniel	0.4	0.2-0.8	.012
Bodyweight categories within frequent breeds	Low	Base		
	Mid	1.7	1.3-2.2	< .001
	High	3.4	2.6-4.5	< .001
	No recorded bodyweight	0.4	0.3-0.6	< .001
Age (years)	< 3.0	Base		
	3.0 - 5.9	2.4	1.8-3.2	< .001
	6.0 - 8.9	3.7	2.7-5.0	< .001
	9.0 - 11.9	4.4	3.2-6.1	< .001
	≥ 12.0	3.3	2.3-4.7	< .001
Sex/neuter	Female entire	Base		
	Female neutered	2.1	1.6-2.9	< .001
	Male entire	0.9	0.6-1.2	.360
	Male neutered	1.3	1.0-1.8	.100
Insurance	Non-insured	Base		
	Insured	4.0	3.2-4.9	< .001