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Canine dystocia in 50 UK first-opinion emergency care veterinary practices: clinical management and outcomes

Dan G O'Neill,[1] Aoife M O'Sullivan,[2] Erin A Manson,[1] David B Church,[1] Paul D McGreevy,[3] Amanda K Boag,[2] Dave C Brodbelt[1]

Abstract

Canine dystocia is a relatively common veterinary presentation. First opinion emergency care clinical data from 50 Vets Now clinics across the UK were used to explore dystocia management and outcomes in bitches. Caesarean section (CS) was performed on 341/701 (48.6 per cent (95 per cent CI 44.9 to 52.4)) of dystocia cases. The bulldog (OR 7.60, 95 per cent CI 1.51 to 38.26, P=0.014), Border terrier (OR 4.89, 95 per cent CI 0.92 to 25.97, P=0.063) and golden retriever (OR 4.07, 95 per cent CI 0.97 to 17.07, P=0.055) had the highest odds of CS among dystocic bitches compared with crossbreds. Brachycephalic dystocic bitches had 1.54 (95 per cent CI 1.05 to 2.28, P=0.028) times the odds of CS compared with non-brachycephalics. Oxytocin was administered to 380/701 (54.2 per cent) and calcium gluconate was administered to 82/701 (11.7 per cent) of dystocic bitches. 12 of 701 dystocia cases (1.7 per cent) died during emergency care. These results can help veterinary surgeons to provide better evidence on the risks to owners who may be contemplating breeding from their bitches. In addition, the results on the management and clinical trajectory of dystocia can facilitate clinical benchmarking and encourage clinical audit within primary care veterinary practice.

Introduction

Canine dystocia is a relatively common veterinary presentation, with a reported prevalence of 3.7 per cent among an emergency caseload in the UK and highest breed prevalence among French bulldogs, Boston terriers, chihuahuas and pugs.[1] With reported mortality rates of over 20 per cent for puppies and 1 per cent for dams,[2] dystocia represents an important welfare challenge, especially in predisposed breeds. Improved epidemiological insights into the veterinary management and outcomes of dystocia could assist in clinical benchmarking and mitigating some of these negative welfare impacts.[3 4]

Options for veterinary clinical management of dystocia in bitches include manual manipulation, medical treatment and/or surgical delivery.[5 6] Oxytocin therapy has been reported in up to 80 per cent of dystocia cases.[5 7–9] However, recommended dosing regimens vary widely.[6 10 11] Caesarean section (CS) may be selected as a non-elective emergency surgery on perceived clinical exigency[2] or as an elective procedure based on either veterinary clinical advice or preferential request by the breeder.[12]

There are few reports on the clinical management and outcomes of dystocia from the first opinion emergency care population but such evidence could influence decision-making by veterinary surgeons and breeders and improve veterinary advice given, particularly for predisposed breeds.[13] Emergency care research can also provide useful benchmarked data for regulators and practitioners to advance appreciation of the benefits of official CS reporting in pedigree dogs[14] and support clinical audit as an important pillar of clinical governance.[15] A recent study based on an emergency care population reported on the prevalence and risk factors of dystocia in bitches.[1] The current study aimed to extend this work by further examining the same study population to explore the clinical management and outcomes of these dystocia cases with particular focus on CS. It was hypothesised that, among the emergency care of dystocia cases, brachycephalic breeds have greater

Veterinary Record (2019) doi: 10.1136/vr.104944

[1]The Royal Veterinary College, Hatfield, UK
[2]Vets Now Ltd, Dunfermline, UK
[3]Sydney School of Veterinary Science, The University of Sydney, Sydney, New South Wales, Australia

E-mail for correspondence: doneill@rvc.ac.uk

Provenance and peer review Not commissioned; externally peer reviewed.

Received March 15, 2018
Revised September 28, 2018
Accepted December 11, 2018

odds of an emergency CS than non-brachycephalic breeds.

Materials and methods

Study population

The VetCompass Programme at the Royal Veterinary College shares veterinary clinical information from UK primary care and emergency care veterinary practices for epidemiological research.[16] Vets Now currently provide an out-of-hours emergency care service from 55 sites across the UK that support over 100,000 emergency patients annually from 1000 primary care practices.[17] Vets Now clinics use a bespoke standardised practice management system (Helix PMS) with the capability to record reason for visit, presenting signs and diagnoses from the VeNom Coding standardised terminology during episodes of clinical care.[18] A clinical query using structured query language was used to extract de-identified selected fields of electronic patient record (EPR) data from the Helix system and upload them to a secure VetCompass relational database.[19]

The sampling frame for the current study included all entire female dogs with at least one EPR recorded within the VetCompass database that attended Vets Now from September 1, 2012, to February 28, 2014.[17] Data used in the current study included demographic (breed, date of birth, sex, neuter, insurance status, bodyweight) and clinical (clinical notes, treatment, presenting signs and diagnosis terms with relevant dates) information. A prevalence study design was used to estimate the proportional usage of various clinical managements and evaluate associations between risk factors and CS among bitches presenting with dystocia.[20] Sample size calculations estimated that 51 brachycephalic dystocia cases and 451 non-brachycephalic dystocia cases were required to detect a 2.5-fold increased odds of CS in brachycephalic compared with non-brachycephalic bitches presenting with dystocia (assuming 50 per cent CS probability in non-brachycephalic dystocia dogs, 10 per cent brachycephalics in the study population, two-sided 95 per cent CI and 80 per cent power).[21]

Data extraction

Candidate dystocia cases were identified from the VetCompass database by searching across five data fields. The clinical notes free-text field was searched using *dyst, disto, labour, labor, cesa, caes, csec, c-sec, birth, partur, whelp, foet, fetal, contraction, litter, breach, breech, oxyto*, *neonat*. The client-reported presenting signs field was searched using *trouble giving birth*. The clinic-reported presenting signs field was searched for *dystocia*. The VeNom diagnosis field was searched for terms that included *dystocia* or *pregnancy,* and the drug treatment fields were searched using *oxyt* and *dopr.* Overall search results were aggregated and randomly ordered to avoid temporal bias during the case review phase.[22]

The full clinical notes of all candidate dystocia cases were reviewed in detail. The case definition for dystocia required presentation for emergency clinical care related to whelping and that the bitch had at least part of one puppy retained internally at initial presentation as assessed by the attending veterinary surgeon.[1] Additional data extracted on dystocia cases described parity, history of dystocia, date of dystocia, diagnostic methods, medical and/or surgical management, and outcomes including litter size, CS, and puppy and dam survival. Information extracted on the causes of dystocia reflected the summative clinical opinion of the veterinary care teams and was not solely reliant on imaging results. Bitches discharged alive from the clinical care of the emergency provider were defined as having survived. Puppies were recorded as 'born alive' if there was evidence of voluntary breath either with or without resuscitation efforts.

Breeds were grouped by purebred/crossbred status, Kennel Club (KC) recognised-breed status (recognised/not recognised) and KC breed group.[23] A *breed* variable included individual breeds with ≥8 dystocia cases, any remaining breeds among the 10 most common individual breeds overall, a grouping of all remaining pure breeds and a grouping of all crossbreds. A *brachycephalic* variable grouped American bulldog, Boston terrier, boxer, bulldog, French bulldog, Pekingese, pug, Shih-tzu and Victorian bulldog as brachycephalic breeds, with all other dogs recorded as non-brachycephalic. *Bodyweight* described the maximum recorded value for each dog during the study period. Data on the oxytocin dose (IU and IU/kg) and calcium gluconate 10 per cent dose (ml and ml/kg) used at the first administration were extracted. Oxytocin therapy was included only where it had been administered to aid contractions for direct expulsion of puppies and did not include oxytocin administered during/after CS or after whelping was completed.

Statistical analysis

Following data checking and cleaning in Excel (Microsoft Office Excel 2007, Microsoft), statistical analyses were conducted using Stata V.13.0. The risk of CS among dystocia cases was reported with 95 per cent CIs derived from standard errors based on approximation to the normal distribution.[24] The chi-square test compared categorical variables and the Mann-Whitney U test continuous variables.[24] Binary logistic regression modelling evaluated risk factor for univariable association with CS. Factors with liberal associations in univariable modelling ($P<0.2$) were taken forward for multivariable logistic regression modelling. Breed and brachycephalic variables are naturally highly collinear, so multivariable modelling explored separately the effects of these two variables that were both of primary interest. Model development used manual backwards

stepwise elimination. Clinic attended was considered as a random-effect and pair-wise interaction effects were evaluated for the final model variables.[25] The Hosmer-Lemeshow test statistic and the area under the receiver operating characteristic (ROC) curve were used to evaluate model fit (non-random-effect model).[25] Statistical significance was set at P<0.05.

Results

Dystocia occurrence

From an overall population of 18,758 entire female dogs attending 50 Vets Now clinics across the UK, 701 dystocia cases were identified for the current study.[1] Of the 668 bitches with breed data available, 628 (94.0 per cent) were purebred and 129 (19.3 per cent) were brachycephalic. The most common breeds among the dystocia cases were chihuahua (n=75, 10.7 per cent), Staffordshire bull terrier (59, 8.4 per cent), pug (43, 6.1 per cent), Jack Russell terrier (43, 6.1 per cent) and crossbred (40, 5.7 per cent) (table 1). The median bodyweight of dystocia cases was 10.0 kg (n=237, IQR 6.2–21.4, range 1.5–66.6), and the median age at dystocia was 3.0 years (IQR 2.0–4.0, range 0.7–14.0).

The cause of dystocia was recorded for 260/701 (37.1 per cent) bitches. The most common recorded causes were fetal malposition (n=90, 34.6 per cent) and fetal–maternal disproportion (80, 30.8 per cent) (table 2). Of the 218/701 (31.1 per cent) bitches with parity information recorded, 99 (45.4 per cent) were primiparous. Of the 119/218 (54.6 per cent) cases recorded as multiparous, 88 had information recorded on their breeding history which showed that 34/88 (38.6 per cent) had previously had dystocia or CS. Diagnostic imaging was performed on 191/701 (27.3 per cent) bitches, with 113/701 (16.1 per cent) having radiography and 92/701 (13.1 per cent) having ultrasonography.

Of 425/701 (60.6 per cent) dystocia cases with litter size information available, the median total litter size was 4 puppies (IQR 3–6, range 1–17). The median number of puppies born alive was 3 (IQR 2–5, range 0–14), and the median number of puppies born dead was 1 (IQR 0–1, range 0–14). The median number of puppies alive at discharge from emergency care was 3 (IQR 1–5, range 0–14). The median total litter size did not differ statistically between primiparous (4, IQR 3–6, range 1–11) and multiparous bitches (4, IQR 2–5.5, range 1–11) (P=0.170).

Medical management

Oxytocin was administered to 380/701 (54.2 per cent) dystocic bitches during emergency care. Of the 134/380 (35.3 per cent) bitches with bodyweight available, the median oxytocin quantity given at first administration was 5.0 IU/dog (IQR 3.0–8.0, range 0.2–50.0), and the median oxytocin dose (IU/kg) at first administration was 0.36 IU/kg (IQR 0.22–0.52, range 0.01–2.08). Of 380 bitches treated with oxytocin, 124 (32.6 per cent) subsequently underwent CS.

Calcium gluconate was administered to 82/701 (11.7 per cent) bitches; 80/82 (97.6 per cent) also received oxytocin therapy. The median volume of calcium gluconate 10 per cent solution administered at first administration was 5.0 ml (IQR 2.0–10.0, range 0.1–44.0), and the median dose (ml/kg) of calcium gluconate 10 per cent solution administered at first administration was 0.41 ml/kg (IQR 0.21–0.59, range 0.02–1.25). Of cases treated with calcium gluconate with information recorded, 14/79 (17.7 per cent) had ionised calcium concentrations measured via blood sample before exogenous calcium administration.

Caesarean section

CS was performed on 341/701 (48.6 per cent (95 per cent CI 44.9 to 52.4)) of dystocia cases. The prevalence of CS among the overall emergency care caseload of entire bitches was 1.8 per cent (95 per cent CI 1.6 per cent to 2.0 per cent). Overall, 106/341 (31.1 per cent) of the CS surgeries also included an ovariohysterectomy procedure. None of the CS surgeries were recorded as elective. The risk of CS within dystocia cases varied widely across the breeds. Breeds with the highest risk included bulldog (86.7 per cent, 95 per cent CI 59.5 to 98.3), Border terrier (80.0 per cent, 95 per cent CI 44.4 to 97.5), golden retriever (76.9 per cent, 95 per cent CI 46.2 to 94.7), springer spaniel (71.4 per cent, 95 per cent CI 28.9 to 82.3) and French bulldog (67.9 per cent, 95 per cent CI 47.6 to 84.1). The probability among crossbreds was 45.0 per cent (95 per cent CI 29.3 to 61.5) (table 3). There was no significant difference in the probability of CS between primiparous (53/99, 53.5 per cent) and multiparous dystocia cases (53/119, 44.5 per cent, P=0.186). Neither the initial dose of oxytocin (P=0.273) nor the total litter size were associated with the odds of CS in dystocic bitches (P=0.116).

Univariable logistic regression modelling identified five variables with liberally significant (P<0.20) association with CS among dystocia cases: breed, brachycephalic breed, KC breed group, bodyweight and insurance. Purebred status (P=0.633) and whether breeds were KC-recognised (P=0.823) were not associated with CS (table 1). The final breed multivariable model comprised two risk factors: breed and insurance. The final model was not improved by inclusion of the clinic attended as a random effect (P=0.270). No biologically significant interactions were identified. The final model showed acceptable model-fit (Hosmer-Lemeshow test statistic: P=0.970) and discrimination (area under the ROC curve: 0.647). Compared with crossbreds, breeds with the highest odds of CS once dystocic were bulldog (OR 7.60, 95 per cent CI 1.51 to 38.26, P=0.014), Border terrier

Table 1 Descriptive and univariable logistic regression results for risk factors associated with caesarean section in bitches with dystocia attending emergency care veterinary practices in the UK

Variable	Category	Dystocia cases, n	Caesarean section, n (%)	OR	95% CI	P value (category)	P value (overall)
Purebred status	Crossbred	40	18 (45.0)	Base			0.633
	Purebred	628	307 (48.9)	1.17	0.61 to 2.22	0.634	
Brachycephalic	Non-brachycephalic	539	251 (46.6)				0.027
	Brachycephalic	129	74 (57.4)	1.54	1.05 to 2.28	0.028	
KC-recognised breed	Not KC-recognised breed	107	51 (47.7)	Base			0.823
	KC-recognised breed	561	274 (48.8)	1.05	0.69 to 1.59	0.823	
KC breed group	Not KC-recognised	107	51 (47.7)	Base			0.121
	Gundog	77	37 (48.1)	1.02	0.57 to 1.83	0.959	
	Hound	45	17 (37.8)	0.67	0.33 to 1.36	0.264	
	Pastoral	23	8 (34.8)	0.59	0.23 to 1.50	0.264	
	Terrier	103	46 (44.7)	0.89	0.51 to 1.53	0.663	
	Toy	172	95 (55.2)	1.35	0.83 to 2.20	0.219	
	Utility	99	55 (55.6)	1.37	0.79 to 2.38	0.258	
	Working	42	16 (38.1)	0.68	0.33 to 1.40	0.292	
Breeds	Crossbreed	40	18 (45.0)	Base			0.002
	Bulldog	15	13 (86.7)	7.94	1.58 to 39.89	0.012	
	Border terrier	10	8 (80.0)	4.89	0.92 to 25.97	0.063	
	Golden retriever	13	10 (76.9)	4.07	0.97 to 17.07	0.055	
	Springer spaniel	14	10 (71.4)	3.06	0.82 to 11.40	0.096	
	French bulldog	28	19 (67.9)	2.58	0.94 to 7.07	0.065	
	Yorkshire terrier	22	13 (59.1)	1.77	0.62 to 5.06	0.290	
	Jack Russell terrier	43	25 (58.1)	1.70	0.71 to 4.05	0.233	
	Chihuahua	75	42 (56.0)	1.56	0.72 to 3.37	0.262	
	Pug	43	23 (53.5)	1.41	0.59 to 3.34	0.440	
	Miniature dachshund	12	6 (50.0)	1.22	0.34 to 4.45	0.761	
	West Highland white terrier	12	6 (50.0)	1.22	0.33 to 4.45	0.761	
	Shih-tzu	15	7 (46.7)	1.07	0.33 to 3.52	0.912	
	Labrador retriever	20	9 (45.0)	1.00	0.34 to 2.94	1.000	
	Boston terrier	9	4 (44.4)	0.98	0.23 to 4.19	0.976	
	Staffordshire bull terrier	59	25 (42.4)	0.90	0.40 to 2.02	0.796	
	Cavalier King Charles spaniel	12	5 (41.7)	0.87	0.24 to 3.22	0.838	
	Border collie	8	3 (37.5)	0.73	0.15 to 3.49	0.697	
	Other purebred dogs	181	67 (37.0)	0.72	0.36 to 1.44	0.349	
	Cocker spaniel	17	6 (35.3)	0.67	0.21 to 2.16	0.498	
	Boxer	12	4 (33.3)	0.61	0.16 to 2.36	0.475	
	German shepherd dog	8	2 (25.0)	0.41	0.07 to 2.27	0.305	
Bodyweight overall (kg)	<10.0	115	75 (65.2)	2.58	0.96 to 6.93	0.060	0.012
	10.0–19.9	56	28 (50.0)	1.38	0.48 to 3.93	0.552	
	20.0–20.9	31	14 (45.2)	1.13	0.36 to 3.59	0.833	
	30.0–30.9	19	8 (42.1)	Base			
	40.0–49.9	13	6 (46.2)	1.18	0.28 to 4.88	0.821	
	≥50.0	3	2 (66.7)	2.75	0.21 to 35.83	0.440	
	No recorded bodyweight	464	208 (44.8)	1.12	0.44 to 2.83	0.815	
Age category (years)	<3.0	268	134 (50.0)	Base			0.905
	3.0–5.9	320	156 (48.8)	0.95	0.69 to 1.31	0.763	
	6.0–8.9	65	28 (43.1)	0.76	0.44 to 1.31	0.317	
	≥9.0	6	3 (50.0)	1.00	0.20 to 5.04	1.000	
	No age data available	42	20 (47.6)	0.91	0.47 to 1.27	0.774	
Insurance	Uninsured	675	323 (47.9)	Base			0.031
	Insured	26	18 (69.2)	2.45	1.05 to 5.72	0.038	

The results shown are based on animals with data available unless otherwise stated.
KC, Kennel Club.

(OR 4.89, 95 per cent CI 0.92 to 25.97, P=0.063) and golden retriever (OR 4.07, 95 per cent CI 0.97 to 17.07, P=0.055) although the Border terrier and golden retriever were not statistically significantly different to crossbreds. Insured dystocic bitches had 2.50 (95 per cent CI 1.04 to 6.04, P=0.042) times the odds of CS compared with uninsured dystocic bitches (table 4).

Multivariable modelling for associations between brachycephaly and CS identified no additional associated factors and, therefore, the univariable results are reported. The final model was not improved

Table 2 Causes of dystocia recorded in 260 of 701 bitches with dystocia attending emergency care veterinary practices in the UK

Cause of dystocia	Bitches, n	All bitches (%)	Each cause that received caesarean section, n (%)
Fetal malposition	90	34.6	40 (44.4)
Feto–maternal disproportion	80	30.8	56 (70.0)
Inertia (unspecified)	51	19.6	24 (47.1)
Primary inertia	20	7.7	11 (55.0)
Congenital pelvic narrowing	8	3.1	7 (87.5)
Secondary inertia	8	3.1	3 (37.5)
Maternal anatomical abnormality	2	0.8	2 (100.0)
Uterine prolapse	1	0.4	1 (100.0)

by inclusion of the clinic attended as a random effect (P=0.402). In support of the study hypothesis, brachycephalic dystocic bitches had 1.54 (95 per cent CI 1.05 to 2.28, P=0.028) times the odds of CS compared with non-brachycephalics.

Clinical care outcomes

In total, 12 of 701 dystocia cases (1.7 per cent) died before discharge; 4 had unassisted deaths and 8 died by euthanasia. Of the 4/12 (33.3 per cent) unassisted deaths, 1 died from gastric dilatation and volvulus, 1 died under general anaesthesia and 2 died from another systemic illness present at time of dystocia. Of the 8/12 (66.7 per cent) bitches that were euthanased, the owners' decision was ascribed to financial concerns about the cost of a recommended CS in 5/8 (62.5 per cent) bitches.

Following initial presentation, 511/701 (72.9 per cent) of dystocia cases completed their puppy delivery at the emergency provider while 159/701 (22.7 per cent) bitches returned home to continue whelping and 31/701 (4.4 per cent) cases were transferred to the routine day-care veterinary practice of the owner or another veterinary practice for continued clinical management.

Table 3 Risk of caesarean section among dystocic bitches treated at first opinion emergency care veterinary practices in the UK (expressed as % with 95 % CIs)

Breed type	Dystocia cases, n	Caesarean section, n	Dystocia with caesarean section (%)	95% CI
Crossbreed	40	18	45.0	29.3 to 61.5
Bulldog	15	13	86.7	59.5 to 98.3
Border terrier	10	8	80.0	44.4 to 97.5
Golden retriever	13	10	76.9	46.2 to 94.7
Springer spaniel	14	10	71.4	28.9 to 82.3
French bulldog	28	19	67.9	47.6 to 84.1
Yorkshire terrier	22	13	59.1	36.4 to 79.3
Jack Russell terrier	43	25	58.1	42.1 to 73.0
Chihuahua	75	42	56.0	44.1 to 67.5
Pug	43	23	53.5	37.7 to 68.8
Miniature dachshund	12	6	50.0	21.1 to 78.9
West Highland white terrier	12	6	50.0	21.1 to 78.9
Breed not recorded	33	16	48.5	30.8 to 66.5
Shih-tzu	15	7	46.7	21.3 to 73.4
Labrador retriever	20	9	45.0	23.1 to 68.5
Boston terrier	9	4	44.4	13.7 to 78.8
Staffordshire bull terrier	59	25	42.4	29.6 to 55.9
Cavalier King Charles spaniel	12	5	41.7	15.2 to 72.3
Border collie	8	3	37.5	8.5 to 75.5
Other pure breeds	181	67	37.0	30.0 to 44.5
Cocker spaniel	17	6	35.3	14.2 to 61.7
Boxer	12	4	33.3	9.9 to 65.1
German shepherd dog	8	2	25.0	3.2 to 65.1

Discussion

This study highlights the relative frequent use of CS in dystocic bitches presenting to emergency clinics and the increased probability in particular among brachycephalic breeds.

The study benefits from a large sample size and wide geographic distribution in the UK that should promote good generalisability of the results.[1] First opinion emergency care veterinary caseloadss have distinct advantages for epidemiological research on canine dystocia because dystocia in dogs is often an emergency veterinary presentation.[13]

The use of diagnostic imaging was recorded for 27 per cent of the dystocic bitches presented in the current study, with 16 per cent of bitches undergoing radiography and 13 per cent having ultrasonography. These values are significantly lower than those from a specialist obstetrics clinic in Germany which reported the use of radiography in 61 per cent and ultrasonography in 55 per cent of dystocic bitches.[5] The lower uptake of diagnostic imaging in the current study may reflect differing patient characteristics between primary versus referral whereby cases referred for more intensive management may have already received primary care attention before referral and may therefore be more severe. Differing general standards of accepted care and cost factors (including cost differentials, and owner expectations of cost and ability to pay) between the UK first opinion emergency care practices relative to the non-UK specialist care centres may also have contributed to these differences. Radiology can assist to determine the number of fetuses and their size, location, disposition and vitality as well as assessing the general condition of the dam's abdomen.[2 26] Ultrasonography can facilitate evaluation of fetal compromise and measure fetal heart rate to evaluate fetal viability and distress.[6 10 13] These benefits suggest that it may be clinically advisable in the first opinion setting to increase uptake of diagnostic imaging in dystocia cases beyond the 27 per cent recorded in the current study.

Calcium gluconate can be administered as a sole agent, or alternatively before, during or after oxytocin therapy.[2 10] Calcium gluconate therapy was administered to 11.7 per cent of cases in the current study with 97.6 per cent of these cases also receiving

Table 4 Final multivariable logistic regression model for risk factors associated with caesarian section in bitches presenting with dystocia at emergency care veterinary practices in the UK

Variable	Category	OR	95% CI	P value
Breeds	Crossbreed	Base		
	Bulldog	7.60	1.51 to 38.26	0.014
	Border terrier	4.89	0.92 to 25.97	0.063
	Golden retriever	4.07	0.97 to 17.07	0.055
	Springer spaniel	3.06	0.82 to 11.40	0.096
	French bulldog	2.44	0.89 to 6.72	0.083
	Yorkshire terrier	1.70	0.59 to 4.90	0.324
	Jack Russell terrier	1.63	0.68 to 3.91	0.269
	Chihuahua	1.51	0.69 to 3.26	0.300
	Pug	1.35	0.57 to 3.21	0.496
	West Highland white terrier	1.22	0.34 to 4.45	0.761
	Miniature dachshund	1.14	0.31 to 4.17	0.847
	Boston terrier	0.98	0.23 to 4.19	0.976
	Shih-tzu	0.95	0.28 to 3.17	0.931
	Labrador retriever	0.91	0.31 to 2.71	0.870
	Staffordshire bull terrier	0.90	0.40 to 2.02	0.796
	Cavalier King Charles spaniel	0.81	0.22 to 3.01	0.750
	Border collie	0.73	0.15 to 3.49	0.697
	Other purebred dogs	0.70	0.35 to 1.41	0.319
	Cocker spaniel	0.63	0.19 to 2.05	0.442
	Boxer	0.61	0.16 to 2.36	0.475
	German shepherd dog	0.36	0.06 to 2.03	0.245
Insurance	Uninsured	Base		
	Insured	2.50	1.04 to 6.04	0.042

oxytocin therapy, suggesting that emergency care veterinary practitioners anticipate benefits from co-administration. Data on the route of administration for calcium gluconate therapy were not available in the current study, and therefore, it is not possible to comment in more detail on the dosages used.

In the current study, 54 per cent of dystocic bitches received oxytocin therapy, similar to the 20–80 per cent previously reported.[5 7 9 27] Oxytocin stimulates uterine contractions to aid expulsion of the puppies, reduces haemorrhage during CS surgeries and assists with postpartum milk let-down and initiation of uterine involution.[8 28] Historically, high oxytocin dosages ranging from 5 to 20 IU of oxytocin have been recommended[8] but lower oxytocin dosages are now encouraged, in a bid to avoid ineffective, tetanic uterine contractions and disruption to uteroplacental blood flow[11 29] and to reduce the risk of uterine rupture, premature placental separation or fetal death.[30] Current recommendations for oxytocin vary and suggest doses ranging from 0.5 to 2.0 IU[10] that can be repeated half-hourly[11] but not exceeding a total oxytocin dose of 20 IU/dog.[6] The median first dose of oxytocin used in the current study was 5 IU/dog but this ranged from 0.2 to 50.0 IU/dog and 12 cases exceeded the recommended maximum dose of 20 IU/dog.[6] These doses were generally higher than those commonly recommended, suggesting either that primary care practitioners perceive higher oxytocin dosages as effective or that there is a need to improve awareness of recent recommendations for lower-dose oxytocin protocols. Following initial management with oxytocin, 33 per cent of cases progressed to CS which is lower than the previously reported probabilities, which ranged from 42 per cent to 75 per cent.[5 7 9 27] This could reflect better selection of candidates for medical management in the current study but may also reflect differing levels of clinical complications between first opinion and referral care.[31]

The prevalence of CS among dystocia cases was 48.6 per cent which is less than the 60–86 per cent reported in previous studies.[5 7 9 32] It should be noted that 27 per cent of bitches in the current study completed their whelping following discharge from emergency care and some of these may have later undergone CS, so the true prevalence of CS may be higher than that reported here. Caesarean surgeries are not without anaesthetic risk in dogs, especially in small and brachycephalic breeds, and therefore the surgical option should be carefully considered.[33]

None of the CS surgeries included in the current study was recorded as an elective procedure. Rationales for elective CS include history of dystocia,[7 13] assumption of fewer complications,[34] high monetary value of particular breed-type puppies,[35] higher financial costs of subsequent emergency surgery or simply convenience.[12 36] Elective CS surgeries are reported to be increasing in frequency, especially in some breeds such as the Boston terrier, bulldog and French bulldog that are reported to have over 80 per cent of UK parturitions by elective CS, but these planned surgeries are unlikely to be scheduled at emergency care facilities.[10 12 37] Therefore, the current study may have underestimated true odds of CS surgeries, especially in certain breeds, although it could also be argued that bitches

undergoing elective CS were not truly dystocia cases by definition and many may have self-whelped if given the opportunity.

In the current study, breeds differed widely in likelihood for CS following dystocia. Breeds with the highest proportion of emergency CS were bulldog (87 per cent), Border terrier (80 per cent), springer spaniel (80 per cent), golden retriever (77 per cent) and French bulldog (68 per cent). These findings are similar to a questionnaire survey of British breeders that reported the highest CS risks in Boston terrier (92 per cent), bulldog (86 per cent) and French bulldog (81 per cent), although this latter survey included both elective and emergency surgeries.[12] An internet questionnaire survey reported CS in 95 per cent of parturitions overall in bulldogs and further reported that emergency procedures accounted for only 10.8 per cent of these overall surgeries.[37] A US study using veterinary practice data reported that the most common breed to undergo caesarean was the bulldog.[38]

The health of brachycephalic dogs is currently under close scrutiny, and therefore, extended understanding of associations between brachycephaly and dystocia management in the wider UK dog population is timely.[39 40] Brachycephalic breeds featured as three of the four breeds with the highest odds of dystocia in the preceding publication to the current study[1] while a breeder survey identified brachycephalic breeds as the top three breeds for CS among dystocia cases.[12] The current study hypothesised that brachycephalic breeds have greater odds of CS than non-brachycephalic breeds, among the emergency care caseloadload of dystocia cases. The findings somewhat support this hypothesis by reporting 1.54 times the odds of CS among brachycephalic breeds but the conclusions are nuanced by wide risk variation across the common brachycephalic breeds. A safer conclusion may be that some (but not all) brachycephalic breeds have increased odds of CS once dystocic and that individual breed is a more important predictor than the brachycephalic status. The pug (OR 1.35) had lower odds of undergoing a CS to resolve dystocia than some other common non-brachycephalic breeds such as the golden retriever (OR 4.07) or springer spaniel (OR 3.06) and also lower than some other common brachycephalic breeds such as the bulldog (OR 7.60) and the French bulldog (OR 2.44). These findings agree with a previous result reporting lower probability of CS among all parturitions in the pug (27.4 per cent) compared with the bulldog (86.1 per cent) and the French bulldog (81.3 per cent), although this 2010 study included both elective and emergency CS.[12] Furthermore, the boxer, a breed previously linked with dystocia,[9] also had relatively low odds for CS (OR 0.61) in the current study as did the Boston terrier (OR 0.98). These findings also differ to the 2010 questionnaire which reported that 92.3 per cent of parturitions in Boston terriers involved CS, although inclusion of elective CS in the questionnaire survey may account for this difference.[12]

The parity results in the current study indicate that 55 per cent of dystocia cases were multiparous, of which 39 per cent had a previous dystocia recorded. These values are comparable with previous reports of 33–72 per cent multiparty among dystocia cases and that 20–42 per cent of bitches presenting with dystocia had a history of dystocia.[5 7 8 41] The current study did not reveal any difference between primiparous and multiparous dystocia cases for the median total litter size or their risk of CS. However, it is difficult to draw firm conclusions about the prognostic value of these predictors because breeders may retire underperforming bitches.[42] Changes in KC terms and conditions in 2010 that prohibited litter registration from dams that had already had two litters delivered by CS, unless there were clear welfare reasons, may have influenced breeding decision-making in the current population.[43]

The current study reported concurrent ovariohysterectomy in 31.1 per cent of CS surgeries, broadly similar to previous studies reporting ovariohysterectomy in 12–32 per cent of CS surgeries.[5 7] Additional ovariohysterectomy may be decided on medical grounds, such as uterine pathology, or may be elective at the request of the owner for financial or welfare reasons to prevent future pregnancy or dystocia events.[44] The updated KC registration terms and conditions from 2010 onwards, as described above, may also increase uptake of ovariohysterectomy at CS.[43]

The current study had some limitations as previously described.[1] Some variables had high proportionality of missing data, especially those relating to bodyweight, parity, litter sizes and puppy survival. Generalisability of the reported dose-per-kg values for oxytocin assumes that bodyweight data are missing completely at random. The overall breed counts under emergency veterinary care varied widely, and consequently, the power of the current study to explore risk factors varied similarly across breeds with higher power for the more common breeds.[25] As discussed above, emergency care veterinary practices rarely perform elective CS. Dystocia cases discharged from emergency care prior to resolution of their dystocia were lost to follow-up.

This study provides evidence on the breed and conformation types that have higher update of emergency CS. These results help veterinary surgeons to provide better evidence on the risks of dystocia and surgery to owners who may be contemplating breeding from their bitches. In addition, the results on the management and clinical trajectory of dystocia can facilitate clinical benchmarking and encourage clinical audit within primary care veterinary practice.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Ethics approval Ethics approval was granted by the RVC Ethics and Welfare Committee (reference number 2014/S338).

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