

SHORT COMMUNICATION

Respiratory compromise in French bulldogs presented with intervertebral disc extrusion

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Abstract

Background: French bulldogs hospitalised for the management of intervertebral disc extrusion (IVDE) are frequently affected by respiratory compromise, typically brachycephalic-associated upper respiratory obstruction and/or aspiration events. We evaluated the occurrence of such respiratory compromise events in French bulldogs presented to two referral hospitals.**Methods:** Clinical data for French bulldogs diagnosed with IVDE were retrospectively collated, including severity of neurological deficits, neuroanatomical localisation, diagnosis, details of respiratory compromise, treatment and outcome.**Results:** A total of 306 dogs diagnosed with IVDE were included. Sixty dogs (19.6%) experienced respiratory compromise, of which 31 dogs (10.1%) progressed to cyanosis, collapse or respiratory arrest.**Limitations:** The study was limited by its retrospective nature. Furthermore, the duration of hospitalisation was not evaluated and the decision for euthanasia was often multifactorial.**Conclusion:** One in five French bulldogs presented with IVDE experienced respiratory compromise. The detrimental welfare effects of this warrant further discussion.

INTRODUCTION

Brachycephalic obstructive airway syndrome (BOAS)-associated breathing difficulties are often at the forefront of welfare-targeted campaigns to reform French bulldog breeding. The breed saw a 2964% increase in registered individuals from 2008 to 2017 to become the most popular breed in the UK.¹ BOAS is characterised by dynamic or static upper respiratory tract obstruction that can result in clinical signs including exercise intolerance, dyspnoea, cyanosis and/or syncope, with potential secondary aspiration pneumonitis or pneumonia. It is also associated with gastrointestinal signs such as regurgitation and inflammatory gastropathy.² Neurological disorders have also been found to be relatively common in French bulldogs, particularly intervertebral disc extrusion (IVDE).³ Anecdotally, in our experience, French bulldogs presenting for further evaluation of suspected IVDE can develop BOAS-

associated respiratory compromise upon arrival or during hospitalisation.

A progressive BOAS-associated respiratory crisis can be triggered or exacerbated by multiple factors, including anxiety, pain and exertion.⁴ IVDE is typically a painful condition affecting ambulation,⁵ and this, alongside the stress of transportation and veterinary assessment, might exacerbate the dog's pre-existing BOAS and result in respiratory compromise. A recent study reported that almost 20% of brachycephalic dogs developed respiratory compromise requiring intensive care unit admission after being hospitalised for an unrelated problem.⁶ French bulldogs have also been documented to have a higher relative risk of aspiration pneumonia,⁷ with postoperative aspiration pneumonia significantly associated with an increased likelihood of death, as is tracheostomy tube placement.⁸ In this study, we evaluated French bulldogs presenting with IVDE and hypothesised

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that respiratory compromise is common in these cases and frequently requires multimodal therapeutic intervention.

MATERIALS AND METHODS

Clinical records from the Royal Veterinary College's (RVC) Queen Mother Hospital for Animals and Fitzpatrick Referrals databases were searched for French bulldogs diagnosed with IVDE (March 2011–February 2021). Age, sex, body condition score, history, neurological examination findings, neuroanatomical localisation (which was then grouped into cervical or thoracolumbar [including both T3–L3 and L4–S3 spinal cord segments] for subsequent statistical analysis), computed tomography or magnetic resonance imaging findings, details of surgical IVDE treatment and outcome were recorded. The modified Frankel score (MFS) was used to categorise the severity of neurological deficits, including cervical IVDEs for simplification and to increase the number of dogs per category: grade 0—clinically normal, grade 1—spinal hyperaesthesia, no neurological dysfunction, grade 2—ambulatory para/tetraparesis, grade 3—non-ambulatory para/tetraparesis, grade 4—para/tetraplegic, with intact nociception, and grade 5—paraplegic with absent nociception in pelvic limbs and tail.^{9,10} Clinical records (including patient kennel sheets) were searched for the following clinical signs consistent with respiratory compromise at the time of presentation or during hospitalisation: increased respiratory rate/effort attributed to BOAS, dyspnoea, cyanosis, collapse and/or respiratory arrest. Records were also searched for documented use of anxiolytic medications for BOAS management, hyperthermia, clinician-determined requirement for active cooling, emergency intubation and/or tracheostomy tube placement and mechanical ventilation, as well as necessitation of BOAS surgery during hospitalisation. Dogs with one or more of these descriptors in the clinical records were included in the respiratory compromise group. A diagnosis of aspiration pneumonia was based on consistent clinical signs and radiographs with or without patient-side ultrasound and airway sampling. All therapeutic interventions were recorded. Cases with incomplete medical records or hospital sheet availability were excluded.

Analyses were conducted using GraphPad Prism (version 9.2.0). Clinical variables were compared between dogs that experienced respiratory compromise and those that did not, as well as between dogs that were euthanased and those that survived to hospital discharge, using a chi-squared test or, if more than 20% of expected values in a contingency/crosstabulation table were below five, a Fisher's exact test. A *p*-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 306 dogs were included in the study. Sixty dogs (19.6%) were affected by respiratory compromise requiring at least one therapeutic intervention, including sedation (*n* = 49), oxygen therapy (*n* = 23), active cooling (*n* = 12), surgical management of BOAS (palatoplasty and/or rhinoplasty) (*n* = 5), intubation (*n* = 3), tracheostomy tube placement (*n* = 1) and mechanical ventilation (*n* = 1). Thirty-one dogs (10.1%) progressed to cyanosis, collapse and/or respiratory arrest. Seven dogs (2.5%) developed aspiration pneumonia, with regurgitation also documented in four of the seven. Six of the 60 dogs with respiratory compromise had a recorded history of previous BOAS surgery.

Thirty-four dogs (11.1%) were euthanased. Of these, eight experienced BOAS-associated respiratory compromise. Two dogs were deemed to require mechanical ventilation due to the severity of their BOAS-associated respiratory compromise; one was euthanased prior to initiating ventilation. One dog was transported to the referral hospital with oxygen supplementation following emergency intubation, mechanical ventilation and subsequent euthanasia. Three dogs had delayed surgical management of their IVDE due to BOAS-associated respiratory compromise (aspiration pneumonia in two dogs and upper airway obstructive event in one). Eight dogs were euthanased after developing clinical signs consistent with progressive myelomalacia (progressive neurological deterioration to flaccid paralysis of the pelvic limbs with absent nociception, cranial advancement of the cutaneous trunci cut off, spinal pain with or without hyperthermia). In all eight dogs, euthanasia was performed prior to the onset of hypoventilation.

Clinical variables were investigated as possible risk factors for respiratory compromise in French bulldogs presented with IVDE (Table 1). Sex, severity of neurological disease, presence of vertebral malformation and history of BOAS surgery were not found to significantly differ between respiratory compromised and unaffected dogs. Dogs from Fitzpatrick Referrals had almost exclusively thoracolumbar neuroanatomical localisations, so only RVC data were used for statistical comparison between cervical and thoracolumbar cases. Thoracolumbar (vs. cervical) neuroanatomical localisation was more common in French bulldogs experiencing respiratory compromise.

Clinical variables were then compared between dogs that were euthanased and those that survived to hospital discharge (Table 2). The proportion of dogs that developed respiratory compromise did not differ between the euthanasia and survival to hospital discharge groups. MFS was found to be significantly associated with euthanasia (*p* < 0.0001), with more severely affected dogs in the euthanasia group. Dogs with absent pelvic limb nociception were 14.8 times more likely to be euthanased than those with intact nociception (95% confidence interval 6.6–32.9). All 34

TABLE 1 Clinical variables in 306 French bulldogs presented with intervertebral disc extrusion, compared between those that developed respiratory compromise and those that did not

Clinical variable	Dogs affected by BOAS-associated respiratory compromise, <i>n</i> (%)	Dogs not affected by BOAS-associated respiratory compromise, <i>n</i> (%)	Total	<i>p</i> -Value
Sex ^a				0.5376
Female	21 (35)	94 (39.3)	115	
Male	39 (65)	145 (60.7)	184	
Neurological grade (modified Frankel score)				0.2415
1	3 (5)	29 (11.8)	32	
2	20 (33.3)	78 (31.7)	98	
3	9 (15)	55 (22.4)	64	
4	17 (28.3)	51 (20.7)	68	
5	11 (18.3)	33 (13.4)	44	
Ambulation status				0.4682
Ambulatory	23 (38.3)	107 (43.5)	130	
Non-ambulatory	37 (61.7)	139 (56.5)	176	
Deep pain perception				0.3303
Positive	49 (81.7)	213 (86.6)	262	
Negative	11 (18.3)	33 (13.4)	44	
Vertebral malformation ^b				0.1274
Present	32 (66.7)	54 (53.5)	86	
Absent	16 (33.3)	47 (46.5)	63	
Neurolocalisation ^c				0.0020
Cervical	6 (15)	39 (42.9)	45	
Thoracolumbar	34 (85)	52 (57.1)	86	
History of BOAS surgery ^b				0.6999
Yes	6 (12.5)	15 (14.9)	21	
No	42 (87.5)	86 (85.1)	128	

Note: Data were analysed using a chi-squared test. *p*-Values in bold were considered statistically significant ($p < 0.05$).

Abbreviation: BOAS, brachycephalic obstructive airway syndrome.

^aSeven dogs did not have their sex recorded.

^bThe presence of vertebral malformation and history of BOAS surgery were recorded from Royal Veterinary College (RVC) clinical records (149 dogs) only due to the availability of full radiological reports and full medical history.

^cDogs from Fitzpatrick Referrals had almost exclusively a thoracolumbar neurolocalisation, so only RVC data were used for statistical comparison between cervical and thoracolumbar cases.

dogs that were euthanased had T3–L3 (with or without spinal shock) or L4–S3 myelopathy.

DISCUSSION

Of 306 French bulldogs presenting with IVDE to two UK referral veterinary hospitals, 19.6% experienced at least one episode of respiratory compromise, with 10.1% progressing to cyanosis, collapse and/or respiratory arrest. This is in agreement with a previous study in which almost one in five brachycephalic dogs developed respiratory compromise after initial evaluation for an unrelated problem.⁶ A previous study using barometric plethysmography documented BOAS in 54% of the study population of French bulldogs.¹¹ Multiple factors can contribute to the development of BOAS-associated respiratory compromise during hospitalisation, including patient temperament, prior experiences in a veterinary setting, concurrent gastrointestinal disease, pain and core temperature.

Interestingly, a higher MFS and lack of ambulation or nociception were not found in dogs with respiratory compromise in our study, suggesting that other factors previously listed might play a larger role. We found that dogs with a thoracolumbar IVDE were more likely to have respiratory compromise than dogs with cervical IVDE, potentially indicating that thoracolumbar IVDEs are more distressing to the patient and/or necessitate longer hospitalisation or more invasive treatment. Alternatively, the dogs with cervical IVDE in our study population might have had milder neurological deficits/pain. The severity of brachycephalic conformation might also be important,^{12,13,14} but was not evaluated in this retrospective study and will be an important goal of future prospective studies, alongside pain scoring and assessment of anxiety.

Thoracic vertebral malformations are an incidental finding in 78%–90% of French bulldogs.^{15,16} However, the presence of kyphosis has been shown to increase the odds of IVDE in the thoracic vertebral column, and scoliosis has been associated with more caudal lumbar

TABLE 2 Clinical variables in 306 French bulldogs presented with intervertebral disc extrusion, compared between dogs that were euthanased and those that survived to hospital discharge

Clinical variable	Euthanasia, <i>n</i> (%)	Survival to hospital discharge, <i>n</i> (%)	Total	<i>p</i> -Value
Neurological grade (modified Frankel score)				<0.0001
0–2	2 (5.9)	128 (47.1)	130	
3	2 (5.9)	62 (22.8)	64	
4	10 (29.4)	58 (21.3)	68	
5	20 (58.8)	24 (8.8)	44	
Neurolocalisation ^a				0.0219
T3–L3 spinal cord segments	23 (67.6)	188 (83.9)	211	
L4–S3 spinal cord segments	11 (32.4)	36 (16.1)	47	
Aspiration pneumonia				0.5653 ^b
Affected	1 (2.9)	6 (2.2)	7	
Not affected	33 (97.1)	266 (97.8)	299	
BOAS-associated respiratory compromise				0.5413
Affected	8 (23.5)	52 (19.1)	60	
Not affected	26 (76.5)	220 (80.9)	246	
Cyanosis, collapse and/or respiratory arrest				0.3636 ^b
Affected	5 (14.7)	26 (9.6)	31	
Not affected	29 (85.3)	246 (90.4)	275	

Note: Data were analysed using chi-squared or Fisher's exact test. *p*-Values in bold were considered statistically significant ($p < 0.05$).

Abbreviation: BOAS, brachycephalic obstructive airway syndrome.

^aNo dogs with C1–C5 or C6–T2 neuroanatomical localisations were euthanased and so were excluded from the neurolocalisation groupings for statistical analysis.

^bFisher's exact test.

disc extrusions.¹⁷ Interestingly, vertebral deformities in people have been associated with compromised pulmonary function; specifically, increasing thoracic spinal curvature was associated with diminished total lung capacity.^{18,19} In our study population, dogs with vertebral malformations were not more likely to experience respiratory compromise. However, future larger studies to evaluate the severity of kyphosis and compare this with airway conformation and pulmonary function would be worthwhile.

We did not identify a higher euthanasia rate in dogs experiencing respiratory compromise. However, affected dogs were being monitored by veterinary professionals in referral hospitals with 24-hour care, including oxygen kennels, sedation and surgical intervention as deemed necessary. Sixty dogs (19.6%) received at least one therapeutic intervention to manage the BOAS-associated respiratory compromise in addition to management of their spinal injury. This has important ethical implications as well as increasing the financial burden on the client. Furthermore, the interventions themselves have associated risks. For example, one study reported that 7% of dogs undergoing BOAS surgery encountered a major complication, including the requirement for a temporary tracheostomy, death or euthanasia,²⁰ while tracheostomy tube placement has been reported to have a major complication rate of 83.3%.²¹

This study is limited by its retrospective nature, the multi-institutional element with inherent variations in clinical records, attending staff and protocols, and the use of subjective assessments such as the MFS. It is possible that some respiratory complications

were not accurately recorded, and hence, the true incidence might be higher. Cervical neuroanatomical localisation cases were almost exclusively from one hospital's clinical records and this might have biased our results by failing to represent the true spectrum or severity of cervical IVDE clinical presentations. The duration of hospitalisation was not specifically evaluated in this study, and the reason(s) for euthanasia was not always clearly described in the clinical records and was often multifactorial in those where it was described. Regurgitation was only assessed in dogs with aspiration pneumonia, and peri-anaesthetic use of omeprazole or other medications aimed to reduce regurgitation or its consequences was not evaluated.

CONCLUSION

One in five French bulldogs presented with IVDE to two referral hospitals experienced respiratory compromise, which could not be predicted by neurological severity. Clients should be made aware of the associated welfare implications and additional costs involved. Our findings further support the growing concerns regarding the complications experienced by, and the overall welfare of, French bulldogs.

AUTHOR CONTRIBUTIONS

Emma Foster and Abbe Crawford designed the study. Emma Foster, Sarah Butterfield and Natalie West collected the data. Emma Foster analysed the data. Emma Foster, Sarah Butterfield, Natalie West, Clare Rusbridge

and Abbe Crawford interpreted the data and drafted and revised the manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare they have no conflicts of interest.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

This is a retrospective study utilising electronic clinical records under adherence to relevant GDPR policy with patients anonymised. Formal ethical approval was therefore not required.

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