The Journal of Veterinary Medical Science

NOTE

Internal Medicine

A specific laryngeal finding in dogs with bronchial vegetal foreign bodies: a retrospective study of 63 cases

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J. Vet. Med. Sci.
81(2): 213–216, 2019
doi: 10.1292/jvms.18-0293

Received: 30 May 2018
Accepted: 13 December 2018
Published online in J-STAGE: 28 December 2018

ABSTRACT. Grass awns commonly cause respiratory disease in dogs; when located in the trachea or bronchi, they cause severe bronchial inflammation and sepsis. The interplay of cough, bronchoconstriction, and mucus secretion can result in a less effective expulsive cough phase, especially when the causal factor persists. The bronchial exudate could consequently become trapped in the upper respiratory tracts of dogs with bronchial vegetal foreign bodies. We retrospectively reviewed endoscopic findings of the upper respiratory tract in dogs that underwent bronchoscopy in our hospital and correlated these findings with the presence of bronchial grass awns. Muco-purulent exudate in the ventral larynx region, between the vocal cords and laryngeal ventricles, was frequently associated with the presence of bronchial grass awns. This laryngeal finding could be secondary to an altered response to grass awn localization in the bronchi. These results should be carefully considered, particularly in countries where grass awns are commonly found.

KEY WORDS: bronchoscopy, canine, cough, grass awn, respiratory distress

Bronchial vegetal foreign bodies are a common cause of respiratory disease in dogs, particularly in hunting or working dogs during spring and summer [9, 12, 15]. Grass awns are usually inhaled during exercise and migrate through the airways. Due to its “torpedo” shape and backward pointing barbs, grass awns tends to migrate through the lung to other regions, such as the pleural space and retroperitoneal cavity [2, 11, 15]. Migration of grass awns into the lungs or pleural cavity may cause abscesses, pneumothorax, and pyothorax, whereas deeper migration into the sublumbar muscles or vertebrae can result in myositis or neurological signs [1, 3, 4, 15, 18]. Localization of the vegetal foreign body in the trachea or bronchi causes a severe bronchial inflammatory reaction and sepsis. Grass awns also introduce bacteria and/or fungi, incite a foreign body response, interfere with local host defenses, and provide a *nidus* for chronic infections [9]. The most important defense mechanism activated by an animal when a foreign body lodges in the bronchial tree, is cough [5, 6, 16, 17]. Additional defense mechanisms associated with cough are bronchoconstriction and mucus secretion [8]. It has been reported [10, 13, 14] that the interplay of cough, bronchoconstriction, and mucus secretion can result in a less-effective expulsive cough phase, particularly when the cause of the pathological condition persists.

We hypothesized that the bronchial exudate can remain trapped in the upper respiratory tract of dogs affected by bronchial vegetal foreign bodies, as a consequence of altered interaction among the defense mechanisms, which reduces the efficacy of the expulsive cough phase. Although migrating grass awn disease is a well-described pathological condition, to the best of our knowledge, endoscopic findings of the upper respiratory tract in dogs with bronchial grass awns have never been reported. Therefore, the purpose of this retrospective study was to review the endoscopic findings of the upper respiratory tract in dogs that underwent bronchoscopy in our hospital and to correlate these findings with the presence of bronchial grass awns.

Electronic medical records of dogs referred to the Veterinary Teaching Hospital of Perugia University for bronchoscopy between January 2011 and December 2015 were reviewed. All dogs that underwent complete bronchoscopy (pharyngoscopy, laryngoscopy, and tracheobronchoscopy) were included. Dogs with intranasal disease, in which bronchoscopy was not performed, were excluded. Bronchoscopy was performed under general anesthesia, using dexmedetomidine and butorphanol as premedication, and propofol for anesthesia induction and maintenance. Each endoscopy was performed using a 6-mm ø × 1,100-mm length flexible video-endoscope (Pentax EPM-3300; Pentax Italia S.r.l., Milan, Italy). When a grass awn was detected and retrieved, bronchoalveolar lavage (BAL) was not performed. In all other cases, BAL was performed for culturing. Bronchoscopy images were retrieved from

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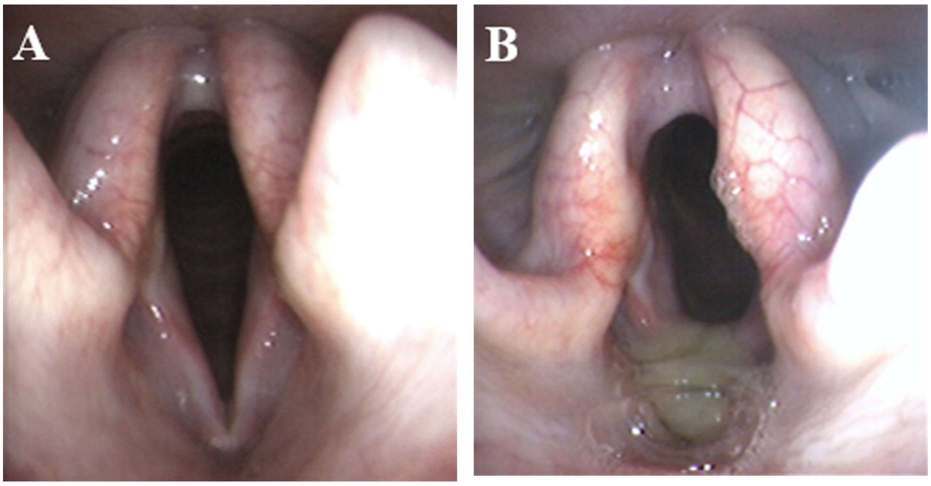

Fig. 1. Bronchoscopic images of the laryngeal region in two different dogs. (A) A dog without and (B) a dog with the presence of muco-purulent exudate in the ventral part of the larynx, between the vocal cords and laryngeal ventricles.

the medical records and reviewed by one of the authors (MCM). From the reviewed data, the following items were collected: clinical signs, presence/absence of a bronchial grass awn, localization of awns, BAL-positive/negative for bacteriological culture, and exudate presence/absence in the upper respiratory tract. Cough was considered acute when present for less than 21 days, and chronic when present for more than 21 days. Finally, the included dogs were classified as hunting and non-hunting dogs. The outcomes were reviewed by telephone consultation with the owners or the referring veterinarians.

Data were collated in an Excel worksheet and descriptive statistics applied. Prevalence of grass awns among hunting and non-hunting dogs and the distribution of grass awn locations were analyzed. Specificity, sensitivity, negative and positive predictive values (NPV and PPV, respectively), and diagnostic odds ratio (DOR) of the presence of exudate in the upper respiratory tract for detection of grass awns were calculated. These values were also calculated in relation to the duration of cough. Finally, the presence of exudate in the upper respiratory tract in relation to the presence of grass awns or in relation to a positive BAL culture was compared by chi-squared test, using both the uncorrected and Yates-corrected test. A value of $P<0.05$ was considered significant for these analyses.

Two-hundred-and-twenty-seven dogs met the inclusion criteria for the study. Cases presented due to cough (n=200) or cough associated with respiratory distress and fever (n=27). In all dogs, bronchoscopic examination allowed good visualization of the larynx, trachea, and bronchial tree. In 89/227 (39%) dogs, a specific laryngeal finding, characterized by the presence of muco-purulent exudate into the ventral part of the larynx between the vocal cords and laryngeal ventricles, was observed (Fig. 1). In 63/227 dogs, grass awns were removed from the bronchial tree by endoscopy. Of these dogs, 49 were hunting-dogs (78%) and 14 were non-hunting dogs (22%). In 52/63 dogs, the grass awns were identified in the right (n=34, 54%) or left lung lobes (n=18, 29%). In 11/63 cases, multiple grass awns were removed from both lungs (17%). In dogs with grass awns, 52/63 (83%) showed the aforementioned specific laryngeal lesion. Clinical and endoscopic findings of the 63 dogs in which grass awns were removed from the bronchial tree are summarized in Table 1. Fourteen percent (31/227) of the dogs received antibiotic therapy at the time of endoscopic examination, while 196/227 (86%) dogs were not under antibiotic therapy for at least 7 days. A diagnosis of tracheobronchitis or tracheal collapse was made in 164/227 (72%) dogs in which grass awns were not visualized. The clinical and endoscopic findings of the 164 dogs in which grass awns were not visualized in the bronchial tree are summarized in Table 2. Any clinical sign related to migration of the grass awns into the body of all the dogs was reported by review of the outcomes. Based on results of bacteriological examination, 60/164 dogs (37%) were classified as BAL-positive and 104/164 dogs (63%) as BAL-negative. Bacteria isolated from the BAL culture, in order of frequency, were Bordetella bronchiseptica, Pasteurella spp., Pseudomonas spp., *Escherichia coli*, Staphylococcus spp., Klebsiella spp., Streptococcus spp., Enterococcus spp., Flavobacterium spp., and Actinobacterium spp. In 36/164 (22%) dogs in which grass awns were not found, the abovementioned laryngeal lesion was described. This laryngeal finding discriminated dogs with bronchial grass awns with a specificity of 75%, sensitivity of 80%, NPV of 91%, PPV of 56%, and DOR of 13.18. Moreover, we evaluated the same parameters in relation to the duration of cough: the laryngeal finding was correlated with acute cough with a specificity of 70%, sensitivity of 77%, NPV of 86%, PPV of 56%, and DOR of 7.85. In dogs with chronic cough, the laryngeal finding showed a specificity, sensitivity, NPV, PPV and DOR of 79, 85, 94, 56 and 20.62%, respectively. Finally, a significant correlation was found between grass awn presence and the pathological laryngeal finding ($P<0.05$). No significant correlation was found between BAL results and the presence of the laryngeal lesion ($P>0.05$).

The results of the present study indicated that a specific laryngeal lesion, characterized by the presence of muco-purulent exudate into the ventral part of the larynx between vocal cords and laryngeal ventricles, could be a predictive sign of the presence of vegetal foreign bodies in the canine bronchial tree. The laryngeal lesion described in our study could be secondary to an

Table 1. Clinical and endoscopic findings in 63 dogs in which grass awns were endoscopically removed from the bronchial tree

Acute cough	Chronic cough	Therapy+	Therapy−	Laryngeal lesion+	Laryngeal lesion−	Grass awn	Grass awns
32 (51%)	31 (49%)	10 (16%)	53 (84%)	52 (83%)	11 (17%)	4 (6%)	59 (94%)

Data are presented as number and percentage (%) of positive clinical or endoscopic findings. Therapy +, dogs receiving antibiotic therapy; Therapy−, dogs that did not receive antibiotic therapy. Laryngeal lesion+, dogs with exudate accumulation in the laryngeal region; Laringeal−, dogs without exudate accumulation in the laryngeal region; Grass awn, dogs with a single grass awn removed endoscopically; Grass awns, dogs with multiple grass awns removed endoscopically.

Table 2. Clinical and endoscopic findings in 164 dogs in which no grass awns were observed in the bronchial tree

Acute cough	Chronic cough	Therapy+	Therapy−	Laryngeal lesion+	Laryngeal lesion−	BAL+	BAL−
66 (40%)	98 (60%)	20 (12%)	144 (88%)	36 (22%)	128 (78%)	60 (37%)	104 (63%)

Data are presented as number and percentage (%) of positive clinical or endoscopic findings. Therapy+, dogs receiving antibiotic therapy; Therapy −, dogs that did not receive antibiotic therapy; Laryngeal lesion+, dogs with exudate accumulation in the laryngeal region; Laryngeal−, dogs without exudate accumulation in the laryngeal region; BAL+, dogs with positive bronchoalveolar lavage culture; BAL−, dogs with negative bronchoalveolar lavage culture.

altered response of the animal to localization of a grass awn in the bronchi. The most important defense mechanism in animals in response to lodging of a foreign body in the bronchial tree, is cough. Cough can be described as a vagally mediated reflex that involves the sequential activation of laryngeal, respiratory, and non-respiratory muscles [8]. This modified respiratory act consists of three phases: an inspiratory phase, a compressive phase, and an expulsive phase. Furthermore, there are some additional and controversial mechanisms associated with cough that may or may not increase its effectiveness: bronchoconstriction and mucus secretion [8]. Excessive bronchial mucus secretion may cause coughing, but on the other hand, coughing may evoke reflex airway mucus secretion that can interfere with the expulsive phase [10, 14]. In addition, O' Donnel *et al.* [13] have reported that, in some cases, excessive bronchoconstriction during coughing may reduce its expulsive effect. The consequences of inhalation of grass awns perpetuate a continuous and highly suppurative bronchial infection and, especially in a chronic state, it can unbalance the complex interactions between cough, bronchoconstriction, and mucus secretion, reducing the power of the expulsive phase [6]. Therefore, some of the bronchial muco-purulent exudate that should be removed from the lower respiratory tract by the expulsive effort of cough remains trapped in the upper respiratory tract, localizing to the ventral part of the larynx. The high sensitivity (80%) and specificity (75%), and the significant correlation ($P<0.05$) between the presence of the laryngeal lesion described in this study and the presence of even a single grass awn supported our hypothesis. Moreover, the DOR of this parameter was 13.75 (where DOR values greater than 1 indicate a good test performance) and was even higher (DOR=20.62) in dogs presenting with a chronic cough, in which the bronchial inflammation is presumed to be more severe and suppurative, making it easier for the abundant exudate to become trapped in the ventral part of the larynx. Additionally, the PPV (56%) and NPV (91%) suggest that this marker was reliable for determining true-positive and true-negative cases. Specifically, dogs negative for the laryngeal lesion are very unlikely to have a vegetal foreign body, due to the high NPV. On the other hand, the lower PPV suggests that the presence of the laryngeal lesion may also be related to conditions other than bronchial grass awns, particularly in Northern countries where grass awns are rare. Moreover, the results of this study suggested that a bacterial lower respiratory infection is probably not related to the laryngeal lesion described in this study: in the BAL-positive group the correlation between these factors was negative, with only 22% of dogs presenting this specific laryngeal finding ($P>0.05$). However, further investigations are needed to verify this result. Predictive values, especially the PPV, are influenced by prevalence of the disease in the population. Specifically, PPV increases, while NPV decreases, with an increase in the prevalence of the disease in a population. The retrospective nature of this study poses a limitation. In order to gain a better understanding of the role of this specific laryngeal lesion and its relation to bronchial grass awns, further case–control studies are needed. On the other hand, the importance of this specific laryngeal sign and its reliability is supported by the high DOR which does not depend upon disease prevalence in the population. The higher prevalence of grass awns in hunting dogs (78%) and higher frequency of right lung localization (72%) were in agreement with the findings of previous studies [2, 5, 9, 12]. The breed predisposition is probably due to the intense outdoor exercise of hunting dogs during the spring/summer season, which increases their exposure to grass awns and consequently their risk of grass awn inhalation [2, 9, 12]. The anatomical characteristics of the canine right lung might be related to the higher prevalence of vegetal foreign body inhalation in this lung [7]. Specifically, at the carina level, the right principal bronchus bifurcates more straightly than the left bronchus, making it easier for inhaled foreign bodies to progress in that direction [7].

In conclusion, the specific laryngeal finding described in this study (a muco-purulent exudate in the ventral part of the larynx, between the vocal cords and laryngeal ventricles) is frequently associated with the presence of vegetal foreign bodies in the bronchial tree. Hence, if this sign is present during bronchoscopy, it should be carefully considered, particularly in countries where grass awns are commonly found. Given the retrospective nature of this study, further investigations are needed to discern the value of this endoscopic finding.

CONFLICTS OF INTEREST. The authors declare that they have no conflicts of interest.

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doi: 10.1292/jvms.18-0293