CASE REPORTS

Capnocytophaga cynodegmi in a Rottweiler Dog with Severe Bronchitis and Foreign-Body Pneumonia[▽]

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***Capnocytophaga cynodegmi* is a zoonotic, gram-negative, capnophilic bacterium that is usually seen in people with infections associated with dog or cat bites. The first reported case of *C. cynodegmi* infection in a dog is described here.**

CASE REPORT

A four-year old, castrated male rottweiler dog initially presented to the University of California—Davis (UCD) Veterinary Medical Teaching Hospital (VMTH) for a 6-month history of respiratory distress and suspected pneumonia. Serial thoracic radiographs performed by the primary care veterinarian prior to referral revealed multiple consolidated lung lobes. At the time of referral, radiographs and a computed tomography scan showed consolidation of multiple lung lobes. A CBC (complete blood count) and serum chemistry were performed. A bronchoscopy was done for culture and sensitivity and cytology for each of the following samples: bronchial lavage, bronchial sputum, and biopsy. The sputum was collected from the tracheal tube used for intubation and anesthesia. The biopsy was also submitted for histopathology. The CBC at that time showed a mild eosinophilia (4.2×10^3 cells/ μ l; reference interval, 0.1×10^3 to 1.25×10^3 cells/ μ l). The cytology of the bronchial lavage and sputum had a marked eosinophilic and moderate pyogranulomatous inflammation with no organisms noted. The biopsy revealed severe, diffuse, chronic eosinophilic bronchitis with eosinophilic granulomas. The cultures of the lavage, sputum, and biopsy tissues were plated on sheep blood agar (Hardy Diagnostics, Santa Maria, CA) for 5 days in 5% CO₂. All cultures were negative. The patient was sent home with fenbendazole, amoxicillin-clavulanic acid, famotidine, sucralfate, and glucocorticoids. Follow-up radiographs while the dog was on a tapering course of glucocorticoids revealed resolution of the consolidation but a persistent bronchial pattern. Over the next 6 months, the patient resumed an active lifestyle but had several episodes of acute respiratory signs presumptively diagnosed as bacterial pneumonia secondary to severe bronchiectasis that was treated with variable success with a

variety of antibiotics (enrofloxacin, amoxicillin, and amoxicillin-clavulanic acid). He also remained on various doses of glucocorticoids, as well as gastrointestinal protectants, during that time.

Due to the recurring episodes, the patient was returned to the UCD VMTH 6 months after the initial presentation for a repeat evaluation of his pulmonary disease and possible lung lobectomy. The patient was in good body condition and was severely tachypneic with a respiratory rate of 36 breaths/min. On thoracic auscultation, crackles were audible over the right hemithorax. The current medications included 20 mg (previously on 40 mg) of prednisone per day, enrofloxacin at 136 mg twice a day (owner occasionally giving every 24 h), amoxicillin at 800 mg three times a day (owner only giving 400 mg every 24 h), and famotidine once daily. A CBC at that time identified a mild leukocytosis due to mild neutrophilia (17.9×10^3 cells/ μ l; reference interval, 0.3×10^3 to 11.5×10^3 cells/ μ l) and monocytosis (1.45×10^3 cells/ μ l; reference interval, 0.15×10^3 to 1.35×10^3 cells/ μ l) with a lymphopenia (0.83×10^3 cells/ μ l; reference interval, 1×10^3 to 4.8×10^3 cells/ μ l) indicative of a glucocorticosteroid leukogram. An arterial blood gas analysis identified hypoxemia, acidemia, and hypercapnia that were explained by the patient's severe pulmonary disease and were consistent with a hypoventilatory condition with associated respiratory acidosis that did not have metabolic compensation. A repeat computed tomography scan revealed extensive fluid accumulation in multiple bronchiectatic airways and consolidation of the ventral aspect of the right and left caudal lung lobes and the right middle and entire accessory lung lobes.

A thoracotomy was elected by the owner, and lung lobectomy of the right middle, accessory, and right caudal lobes was performed. Prior to tissue fixation, aseptic technique was used for gross dissection of each lung lobe. A large parenchymal abscess with a plant awn in situ was identified in the accessory lung lobe (Fig. 1A). Cytology and culture were performed on both bronchial fluid and the abscess fluid. Cytology of both sites revealed many moderately to markedly degenerate neutrophils and large amounts of mucus in the background. High

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A

B

FIG. 1. (A) Gross image of accessory lung lobe sectioned just after surgery and prior to fixation. The plant awn is within the abscess that is surrounded by pale parenchymal tissue. Note the exudate in all of the airways. (B) Cytology of the sputum sample from the canine patient. Wright's-Giemsa stain; magnification, $\times 600$. Note the markedly degenerate neutrophils and the monomorphic population of thin, rod- to filament-shaped bacteria within neutrophils and in the background substance. (C) Hematoxylin-and-eosin-stained lung biopsy sample; magnification, $\times 40$. Note the suppurative inflammation in the airway.

numbers of a monomorphic population of thin, rod- to filament-shaped bacteria were noted. A small clear zone was noted around each organism. Many organisms were present intracellularly in neutrophils and extracellularly throughout the sample (Fig. 1B).

The histopathology showed a large plant awn within the accessory lobe with associated chronic, severe, suppurative bronchitis and secondary bronchiectasis of the accessory and caudal lung lobes. In addition, there was a severe suppurative bronchopneumonia with fibrosis that was consistent with secondary bacterial infection (Fig. 1C) in all of the lobes submitted. No evidence of the prior eosinophilic inflammation was identified on any sample.

Cultures from the pulmonary tissue sample obtained at biopsy were grown on sheep blood agar in 5% CO₂. These samples gave rise to a pure growth of β -lactamase-positive, gram-negative rods that was identified by 4 days of incubation and was suspected to be *Capnocytophaga* sp. The cultures from bronchial sputum had similar growth. No additional aerobic or anaerobic bacteria were cultured during 5 days of incubation in 5% CO₂.

16S rRNA sequencing samples were obtained and purified from colonies grown on sheep blood agar with the QiaAmp Tissue Extraction Kit (Qiagen, Inc., Valencia, CA) by following the manufacturer's instructions. Amplification was performed with a thermal cycler (Bio-Rad). PCR products were run on a 1% agarose gel with a low-molecular-weight DNA

ladder. The PCR products were purified with a Microcon Kit (Millipore Corp., Bedford, MA) by following the manufacturer's suggestions. The purified product was submitted to Davis Sequencing (University of California, Davis, CA). The sequence result was 99% identical to *Capnocytophaga cynodegmi*. The patient was further treated with enrofloxacin and a low dose of prednisone.

The patient had an uneventful recovery, returning to the VMTH for follow-up examinations. The owner reports the patient's quality of life to be returning to normal, with much increased energy and playfulness. He remained on oral enrofloxacin and glucocorticosteroids for several months following the surgery. Radiographs taken during the first several follow-up examinations showed residual bronchiectasis in the lung lobes that were not removed during the lobectomy. One year later, the patient was still alive.

C. cynodegmi, formerly known as CDC dysgonic fermenter-2-like, is a fastidious aerobic, capnophilic, gram-negative, fusiform bacillus that is about 2 to 4 μ m long and can be slightly curved at the end (1, 3, 5, 11, 13, 14, 16, 20). The name *cynodegmi* is derived from the Greek kyno (dog) and degmos (bite). *C. cynodegmi* has been found in the saliva, gingival crevices, and nasal cavities of 16% of dogs and 18% of cats (6,

8, 11, 14, 17, 22), which helps to explain why up to 80% of the reports of this organism involve dogs biting people (9, 13).

The patient afflicted with *Capnocytophaga* infection in this report is a dog, which to our knowledge has not been previously reported. Despite this, *C. cynodegmi* and *C. canimorsus* (formerly CDC DF-2, a close relative of *C. cynodegmi*) are rarely isolated from animal bite wounds compared to many other species of bacteria. Some *Capnocytophaga* sp. infections have been associated with other types of close animal contact, raising the concern of zoonotic potential (10, 11, 14, 17, 19, 22). *C. cynodegmi* typically causes localized cellulitis of various severities (9, 13, 15, 16, 19). Other local infections such as keratitis can occur (8, 14). Systemic infections such as meningoencephalitis and generalized sepsis have been reported in splenectomized patients, as well as those with predisposing conditions such as diabetes, alcoholism, and cirrhosis (3, 5, 14, 20). Recently a *C. cynodegmi* respiratory infection was reported in a cat with underlying pulmonary neoplasia (7). The risk of zoonosis from animals with *C. cynodegmi* respiratory infections remains unclear.

While the oral cavity was suspected to be the origin of the *C. cynodegmi* in this patient, the reasons for its development into a pathogen in the lungs likely involve the foreign body. Plant awns migrating through the oral cavity into the respiratory tract may pick up and carry organisms to their final destination, serving as both the vehicle and nidus for the development of bacterial bronchopneumonia. Factors that could have contributed to this patient's risk for an uncommon cause of bacterial pneumonia include generalized immunosuppression from chronic prednisone use, as well as the altered local respiratory tract defense mechanisms seen with chronic bronchitis and bronchiectasis. Additionally, prior antibiotic use may also have played a role in selecting against other common bacterial organisms, leading to a pure infection of *C. cynodegmi*.

The patient had also been prescribed enrofloxacin during his first admission to the VMTH, prior to the lobectomy. *C. cynodegmi* is reported to be sensitive to this antibiotic (7, 13); however, absorption of an antibiotic into an encapsulated purulent lesion is restricted and highly reliant on the degree of abscess maturation. Pharmacokinetic data from in vivo studies demonstrate that substantial antibiotic concentrations can be reached within abscesses in humans and animals, provided the appropriate agent is selected and an optimal dosing regimen is followed as suggested. Nevertheless, the efficacy of antibiotics in exudate may be hindered by various factors, such as acidic pH, protein binding, and degradation by bacterial enzymes (23). In addition, severe gram-negative pulmonary infections often need parenteral antibiotics and are sometimes complicated by antibiotic resistance (9). There are no specific guidelines for this organism when using enrofloxacin. Therefore, the therapeutic dose was obtained by relying solely on the MIC result. This result is useful for determining the dose to be given, but the actual therapeutic dose range can depend on many factors, such as the type of infection, location, and bioavailability. The patient began to improve only after his lobectomy and parenteral antibiotics were administered. All together, this evidence suggests that antibiotic resistance and/or persistence of the foxtail nidus were involved in the perseverance of the patient's disease.

Additional complexities in this case involve the differences among the cytological, histopathological, and microbiological findings of the first and second evaluations. It was believed that the patient initially suffered from a form of idiopathic eosinophilic disease previously reported rarely in dogs including rottweilers (21). While the disease state initially identified could explain the clinical signs and diagnostic findings as sequelae of severe eosinophilic inflammation, the presence of the foreign body and *C. cynodegmi* infection for the entire duration cannot be ruled out. The eosinophilic inflammation may have been due to a hypersensitivity reaction of initial exposure to the plant awn, and some bacterial infections have also been associated with this type of inflammation (4, 12, 18). *C. cynodegmi* is a fastidious organism, and while growth may be detected in as early as 3 days, 7 to 10 days is more common (8, 14). Inadequate duration of culture could lead to a false-negative microbiologic investigation for *Capnocytophaga*. Cultures submitted to the UCD VMTH microbiology laboratory are routinely cultured for 5 days in 5% CO₂ unless other conditions are specified. In some cases, growth of *Capnocytophaga* from lesions may be missed due the polymicrobial nature of most infected bites or foreign body lesions as other organisms may grow more quickly (11). As the name implies, the organism is capnophilic, and though there are subtle differences in reported growth conditions, all sources agree that a 5% CO₂-enriched atmosphere improves growth (1, 3, 8, 11, 13, 14, 19, 20).

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