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Pneumatosis coli in a dog – a serial radiographic study: a case report

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ABSTRACT: A 12-year-old intact female poodle was presented with a history of an acute episode of tenesmus and passage of ribbon-shaped stools. Anaemia, leucocytosis, hypoalbuminaemia, hyperglycaemia, and elevated ALP were found. Faecal floatation and wet mount preparation were negative for parasites. Anaerobic faecal culture resulted in a heavy growth of *Clostridium*. Survey abdominal radiographs revealed extensive intramural emphysema of colon and rectum. Ultrasonography of the abdomen revealed bright echoes within the layers of the colon wall, confirming the accumulation of intramural gas. Abdominal computed tomography revealed extraluminal gas tracking along the colon and the rectum. Based on the radiographic, ultrasonographic, and computed tomographic findings, the present case was diagnosed as pneumatosis coli with an underlying cause of bacterial overgrowth. The patient was treated with antibiotics for seventeen days. Clinical signs were resolved after three days of treatment. Decreased intramural gas accumulation was evident during radiography of the abdomen performed at fourteen days after the initial evaluation. Therefore, pneumatosis coli should be considered when a dog is presented with clinical signs of colitis.

Keywords: colon; computed tomography; dog; emphysema

Pneumatosis coli (PC) is a rare intestinal disorder in dogs characterised by intramural emphysema of the large intestine (Degner 1992; Aste et al. 2005; Choi et al. 2009; Song et al. 2013). The pathogenesis of PC is still unclear. The aetiology of PC gas has been divided into primary and secondary forms (Kircher et al. 2008; Choi et al. 2009). In humans, the secondary form is associated with ulcers, obstructive pulmonary disease, and bacterial overgrowth (Pear 1998; Kircher et al. 2008). The possible causes of PC in dogs include neoplasia, ulcers, mucosal tears, administration of enemas, maliciously introduced foreign bodies, bacterial overgrowth, and surgery (Degner 1992; Morris 1992; Aste et al. 2005). The clinical characteristics of PC are non-specific large bowel disorder signs such as diarrhoea, haematochezia, abdominal pain, constipation, weight loss, and tenesmus (Degner 1992; Morris 1992; Pear 1998; Aste et al. 2005; Choi et al. 2009).

Although radiography and ultrasonography are commonly used for the abdomen, computed tomography (CT) is considered the best imaging modality to establish a definitive diagnosis of PC in humans (Ho et al. 2007; Choi et al. 2009). On both radiographs and CT, PC usually appears as a gas density linear or bubbly pattern of gas in the large bowel wall (Aste et al. 2005; Brauwer et al. 2005; Ho et al. 2007). Ultrasonography findings of PC have been described as bright echoes within the layers of the large bowel wall (Aste et al. 2005; Song et al. 2013). Treatment options for symptomatic PC include antibiotics, oxygen therapy, and less commonly, surgery (Degner 1992; Pear 1998; Aste et al. 2005). Usually, no treatment is necessary for dogs who are asymptomatic (Morris 1992; Choi et al. 2009). Resolution of gas collections has been reported after antibiotics or oxygen therapy (Degner 1992; Pear 1998; Aste et al. 2005; Brauwer et al. 2005; Choi et al. 2009). Good results can be achieved in most cases by conservative means. However, surgical treatment may be necessary for some cases (Degner 1992; Pear 1998; Aste et al. 2005; Kircher et al. 2008; Choi et al. 2009). Here, we describe the imaging findings and serial changes of pneumatosis coli in a dog.

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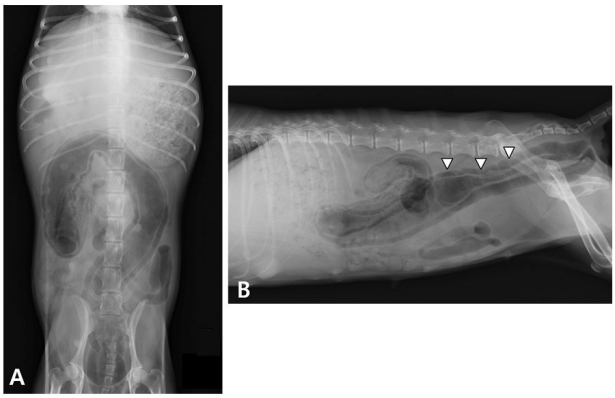

Figure 1. Ventrodorsal (**A**) and right lateral (**B**) abdominal radiographs of the dog. The colon had a lumen containing gas, linear soft tissue opacities, and linear gas opacities externally (arrowheads). The findings were suggestive of pneumatosis coli

Case description

A 12-year-old intact female poodle was presented to the Small Animal Clinic at Gyeongsang National University, Veterinary Medical Teaching Hospital after an acute episode of tenesmus and passage of ribbon-shaped stools. Clinical signs had begun a few days previously. There was no history of trauma or pulmonary disease. On physical examination, the dog had moderate signs of depression with mild dehydration. The respiratory rate and pulse rate of the patient were within normal ranges.

Haematological abnormalities included leucocytosis (14.0×10^9/l, reference range: $6–17 \times 10^9$/l), erythrocytopenia (4.22×10^{12}/l, reference range: 5.5 to 8.5×10^{12}/l), mild anaemia (HCT = 26%, reference range: 37–55%), and thrombocytosis (635×10^9/l, reference range: $37–55 \times 10^9$/l). The biochemical profile revealed increased alkaline phosphatase (ALP) levels (> 40.1 μkat/l, reference range: 0.33 to 2.5 μkat/l), hyperglycaemia (23.5 mmol/l, reference range: 4.1–7.9 mmol/l), and mild hypoalbuminemia (24 g/l, reference range: 25–44 g/l). Faecal flotation and wet mount preparation were negative for parasites. Anaerobic faecal culture resulted in a heavy growth of *Clostridium*.

As part of the gastrointestinal evaluation, abdominal radiographs were made. Analysis of the abdominal radiographs revealed extensive intramural emphysema of the colon and the rectum (Figures 1A and 1B). Ultrasonography of the abdomen revealed bright echoes within the layers of the colon wall, confirming the accumulation of intramural gas (Figures 2A and 2B). Abdominal computed tomography revealed extraluminal gas tracking along the colon and the rectum (Figures 3A and 3B). Based on imaging results, a diagnosis of PC was made.

The dog was treated with metronidazole (15 mg per ml, Metronidazole, CJ HealthCare Corp., Seoul, Korea), amoxicillin-clavulanic acid (12.5 mg/kg, Amoxicillin Hydrate and Clavulanate Potassium, Zoetis Pharm Co., LTD., Seoul, Korea), famotidine (0.5 mg/kg, Famotidine, Nelson Pharm Co., LTD., Chungcheongbukdo, Korea), and pantoprazol (0.5 mg/kg, Pantoprazol Sodium Sesquihydrate, Myungmoon Pharm Co., LTD., Seoul, Korea) orally *q*12 h for 17 days. Clinical signs were resolved after three days of treatment. Gradual decrease of intramural gas accumulation was evident during radiography of the abdomen performed at two days and three days after the initial evaluation (Figures 4A, 4B, 4D and 4E). Fourteen days after the initial treatment, the gas dissipated (Figures 4C and 4F).

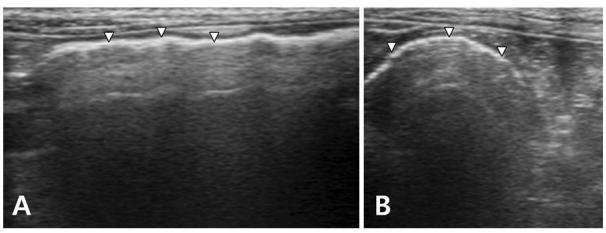

Figure 2. Longitudinal (**A**) and transverse (**B**) ultrasonographic images of the abdomen of the dog. Intramural gas was seen as a linear hyperechoic area, (arrowheads) within the wall showing a reverberation artefact

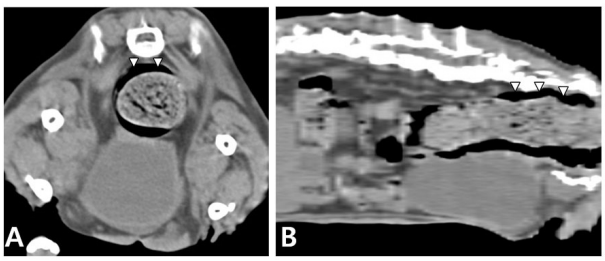

Figure 3. Transverse (**A**) and sagittally reconstructed (**B**) CT images of the abdomen of the dog. An abdominal CT image showing linear intramural air density (arrowheads) in the colon and the rectum

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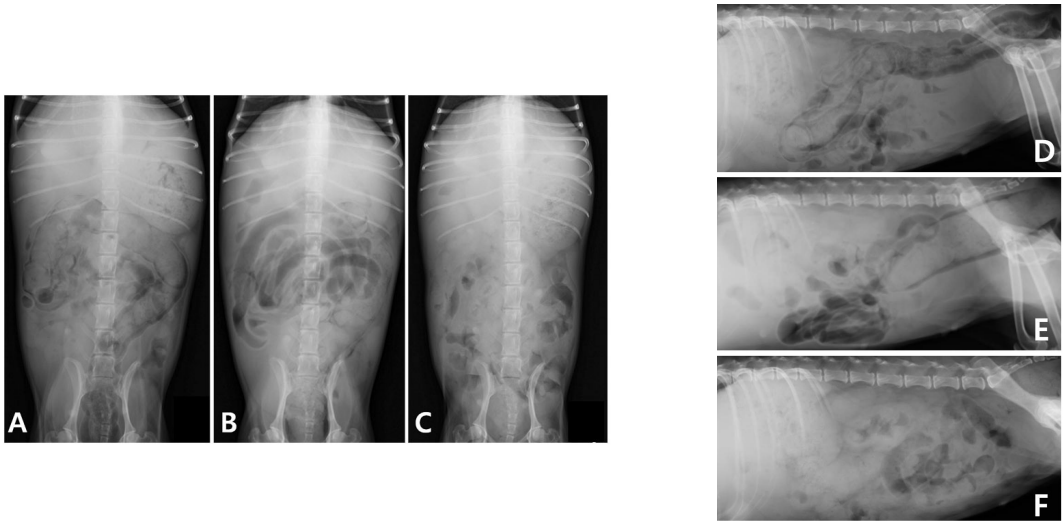

Figure 4. Ventrodorsal (**A**, **B**, **C**) and right lateral (**D**, **E**, **F**) abdominal radiographs of the dog. Decreased intramural gas accumulation was evident during radiography of the abdomen performed two days (**A**, **D**) and three days (**B**, **E**) after the initial evaluation. By fourteen days (**C**, **F**) after the initial treatment, the gas had dissipated

DISCUSSION AND CONCLUSIONS

PC is a rare condition in which gas is found inside the submucosa or subserosa of the large bowel wall (Degner 1992; Morris 1992; Aste et al. 2005; Choi et al. 2009; Song et al. 2013). PC is a rather unspecific sign. It can be found in a wide range of clinical settings (Brauwer et al. 2005). PC has been reported in humans of all ages and in both sexes (Degner 1992; Choi et al. 2009).

Different pathophysiological mechanisms have been proposed to explain the multifaceted conditions associated with PC in humans. Three main hypotheses (mechanical hypothesis, pulmonary hypothesis, and bacterial hypothesis) have been proposed to explain the presence of gas within the wall of the gastrointestinal tract (Degner 1992; Pear 1998; Aste et al. 2005; Choi et al. 2009). In the mechanical hypothesis, luminal gas enters the wall of the intestine through a defect in the intestinal mucosa. This circumstance may develop because of an increase in the intraluminal pressure from bowel obstruction, ileus, or iatrogenically from endoscopy, forcing the gas through tiny defects or pre-existing ulcers in the mucosa (Degner 1992; Pear 1998; Aste et al. 2005; Brauwer et al. 2005; Choi et al. 2009). The pulmonary hypothesis has been formulated to account for PC in patients with chronic obstructive pulmonary disease. Severe coughing may result in alveolar rupture and dissection of air along vascular channels in the mediastinum, tracking caudally to the retroperitoneum and then in the subserosa of the gastrointestinal tract (Degner 1992; Pear 1998; Aste et al. 2005; Brauwer et al. 2005; Choi et al. 2009). The bacterial hypothesis proposes that gas-forming bacteria can enter the submucosa through mucosal rents or increase the mucosal permeability, thus producing gas within the bowel wall (Degner 1992; Pear 1998; Aste et al. 2005; Brauwer et al. 2005; Choi et al. 2009). *Clostridium* spp. have been found in the gastrointestinal tract as part of the normal flora. However, usually they are unable to invade the bowel wall (Kircher et al. 2008; Choi et al. 2009). An altered permeability of intestinal barrier function is a precondition that may result in an infection with *Clostridium*, leading to intestinal gas gangrene (Kircher et al. 2008; Choi et al. 2009). Possible causes for disorders in intestinal barrier function include cytokines, toxins, inflammation, hormones, and hyperosmotic stress (Kircher et al. 2008; Choi et al. 2009). The pulmonary route was unlikely to be the explanation in this case as the dog had no evidence of respiratory disease. Rather, the underlying cause may have been bacterial. This hypothesis is supported by the heavy growth of *Clostridium* on faecal culture.

Radiography and computed tomography are considered as the best diagnostic test in humans (Fisher 1984; Kernagis et al. 2003; Brauwer et al. 2005; Ho et al. 2007; Kircher et al. 2008). However, most PC cases reported in dogs have been diagnosed by radiography (Degner 1992; Morris 1992; Aste et al. 2005; Choi et al. 2009; Song et al. 2013). Diagnostic findings of PC are linear or bubbly pat-

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terns of gas accumulations in the bowel wall (Degner 1992; Morris 1992; Aste et al. 2005; Choi et al. 2009). However, the likelihood of a false-negative result is high for small amounts of gas within the intestinal wall (Ho et al. 2007; Song et al. 2013). In this case, abdominal radiographs revealed extensive intramural emphysema of the colon and the rectum. Decreased intramural gas accumulation in the ascending and transverse colon was evident during radiography of the abdomen performed two days after the initial treatment. Three days after the initial treatment, the gas had nearly dissipated in the colon except for the descending colon. Radiographs taken at two weeks after the presentation showed complete resolution of intramural colonic emphysema.

The ultrasonography findings of PC have been described as bright echoes within the layers of the large bowel wall (Aste et al. 2005; Song et al. 2013). The finding of intramural gas should be differentiated from intraluminal gas, free abdominal gas, and intramural fat (Lang et al. 2011; Song et al. 2013). However, differentiating intraluminal gas from intramural gas by ultrasonography may be difficult in some cases (Song et al. 2013). In the present report, the presence of bright echoes was identified within the mucosal layer of the colon.

Although PC can be seen on abdominal radiographs, CT is the most sensitive imaging modality for the identification of PC (Kernagis et al. 2003; Ho et al. 2007). In humans, the use of CT to detect PC appears to be increasing as a possible consequence of the increased use of CT technology (Ho et al. 2007). CT also appears to be more sensitive than radiography for the detection of hepatic portal and portomesenteric venous air, the presence of which can increase the possibility of PC (Fisher 1984; Ho et al. 2007). The detection of hepatic portal or portomesenteric venous air can help distinguish benign causes of PC from life-threatening causes of PC (Ho et al. 2007). However, although dogs need to be under general anaesthesia and with temporary clinical signs, PC has rarely been diagnosed by CT (Choi et al. 2009; Song et al. 2013). Because the dog had depression, we did not use an anaesthetic for the CT scan. The abdominal CT scan showed linear pattern gas within the colon wall without hepatic portal or mesenteric venous gas. Based on this finding, we considered that the prognosis was excellent.

Surgical intervention is rarely indicated because the condition can be treated conservatively without surgical intervention (Degner 1992; Fischetti et al. 2004; Aste et al. 2005; Brauwer et al. 2005; Choi et al. 2009). In this case, antibiotic treatment was used based on the hypothesis that gas-forming bacteria were responsible for the gas formation. Clinical signs were resolved and the gas dissipated after the treatment.

On both radiographs and CT, different types of gas formation may appear with bubble-, linear-, or curvilinear-shaped patterns (Sud et al. 1996; Pear 1998; Choi et al. 2009). The curvilinear form of PC is usually benign. It is most often seen with pneumatosis cystoides intestinalis (Pear 1998; Ho et al. 2007). The linear or bubble form of PC can develop due to both benign and life-threatening causes. Radiographic or CT appearance alone does not allow the differentiation between the two (Pear 1998; Ho et al. 2007). In humans, the linear form of PC appears to be more characteristic of bowel ischaemia with the presence of portal venous air than bubbly PC which is often benign (Sud et al. 1996). Gas within the intestinal wall that does not change location with different patient positioning is considered as a sign of a more malignant process (Sud et al. 1996; Fischetti et al. 2004). However, linear-shaped gas is most often seen with PC in dogs (Degner 1992; Morris 1992; Aste et al. 2005; Choi et al. 2009). Spontaneous recovery has been demonstrated within a few days to two weeks (Degner 1992; Aste et al. 2005; Choi et al. 2009). In the present report, the presence of linear-shaped gas was identified within the intestinal wall. At fourteen days after the initial treatment, the gas dissipated. In this regard, the type of gas cannot be considered as critical.

In conclusion, the presence of gas in the wall of the colon may be helpful in diagnosing PC using radiography, ultrasonography, and computed tomography in dogs where the underlying cause is bacterial overgrowth. The gas was resolved spontaneously with medical treatment. Therefore, PC should be included in the differential diagnosis for dogs showing non-specific colorectal signs.

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