

Infectious endocarditis caused by gas-producing *Escherichia coli* in a diabetic dog

A 10-year-old, female West Highland white terrier was presented with poorly controlled diabetes mellitus and a previously undetected heart murmur. Emphysematous cystitis, emphysematous peritonitis and infective endocarditis of the tricuspid valve with gas accumulation were diagnosed with radiographs, including non-selective angiocardigraphy. The diagnoses were confirmed by post-mortem examination and positive cultures for *Escherichia coli* in blood, urine and tricuspid valve tissue samples.

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INTRODUCTION

Emphysematous cystitis and peritonitis are infrequent but known complications of bacterial urinary tract infection in diabetic dogs (Adams and Syme 2005). Bacteria previously found to be associated with such infections include *Escherichia coli*, *Aerobacter aerogenes*, *Proteus* species and *Clostridium* species (Petite and others 2006). To the authors' knowledge, no previous reports have been made of infective endocarditis (IE) with endocardial gas accumulation caused by a gas-producing bacteria in any veterinary or human patient.

CASE HISTORY

A 10-year-old, entire female West Highland white terrier was presented with a four day history of lethargy, inappetence, vomiting and diarrhoea. The dog had been diagnosed with diabetes mellitus and lower urinary tract infection caused by *Staphylococcus intermedius* six weeks before presentation. The urinary tract infection had been treated with cephalosporin antibiotics (20 mg/kg Cefazolin orally every 12 hours for 10 days). Diabetes was treated with insulin injections (12 iu Caninsulin[®] subcutaneously every 24 hours). Four weeks before presentation, the initial symptoms of diabetes (polyuria and polydipsia) had improved and urine culture was sterile, but a 24 hour blood glucose curve sug-

gested insulin resistance (peak blood glucose 25 mmol/l, nadir 20 mmol/l). Insulin therapy was continued at the same dosage, and an ovariohysterectomy was performed three weeks before presentation. Two weeks later (one week before presentation), a central venous catheter was placed to perform a 24 hour blood glucose curve, which revealed improved diabetic control (peak blood glucose 25 mmol/l, nadir 9 mmol/l) and urine culture was again negative. Four days before presentation, the dog had been treated on an emergency basis for vomiting and diarrhoea. At this time, blood glucose measurements revealed a mild hyperglycaemia (8.49 mmol/l, reference 3.55 to 5.33 mmol/l), and the haematocrit (0.55; reference 0.4 to 0.55) and total protein level (72 g/l, reference 60 to 72 g/l) were at the upper end of reference intervals, consistent with dehydration. A urine test strip evaluation was positive for glucose and blood but negative for ketones. At this time, the dog was treated with crystalloids through a peripheral venous catheter for 24 hours and was discharged home.

At presentation, the dog was severely lethargic. Physical examination revealed pale mucous membranes, a prolonged capillary refill time and tachypnoea (44 breaths per minute). On auscultation, a previously undetected systolic heart murmur, more pronounced on the right side, with a loud musical click at the end was noted. At this time, the dog was given intravenous fluid therapy and a central venous catheter was placed to monitor central venous pressure. A complete blood count revealed a marked left shift and severe thrombocytopenia. A serum biochemical profile revealed marked hyperglycaemia, increased serum urea, increased serum phosphorus, increased alkaline phosphatase and increased γ -glutamyl transpeptidase. Venous blood gas analysis revealed a metabolic acidosis (Table 1). Urinalysis revealed glucosuria and ketonuria. Blood and urine cultures harvested at presentation later revealed the growth of *E. coli*.

Abdominal ultrasound was performed and revealed gas accumulation in the

Table 1. Abnormal blood values

	Blood values on the day of presentation	Reference values
Leucocytes (/l)	11.5×10 ⁹	6×10 ⁹ to 12×10 ⁹
Segmented neutrophils (/l)	6.9×10 ⁹	3×10 ⁹ to 11.5×10 ⁹
Band neutrophils (/l)	3.8×10 ⁹	0×10 ⁹ to 0.3×10 ⁹
Thrombocytes (/l)	10×10 ⁹	150×10 ⁹ to 400×10 ⁹
Blood glucose (mmol/l)	41	3.55-5.33
Urea (mmol/l)	29.23	4.16-8.32
Phosphorus (mmol/l)	3.41	0.68-1.81
Alkaline phosphatase (iu)	767	9-120
γ-Glutamyl transpeptidase (iu)	26	0-6
pH _{venous}	7.299	7.35-7.45
pCO _{2venous} (mmHg)	25.5	35-45
Bicarbonate _{venous} (mmol/l)	12.2	17-23

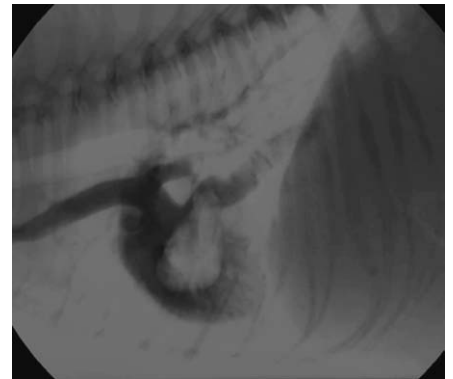


FIG 4. Non-selective angiography showing the gas opacity accumulated and fixed at the area of the tricuspid valve

bladder lumen, bladder wall and ventral abdominal wall. Echocardiography yielded a large hyperechoic structure at the area of the tricuspid valve that produced reverberations, making a thorough examination of the heart difficult (Fig 1). The ultrasonographic examination was followed by lateral and ventrodorsal abdominal and thoracic radiographs. They confirmed the presence of gas accumulation in the bladder lumen, bladder wall and ventral abdominal wall and revealed a well-defined gas opacity superimposed over the right ventricular area of the cardiac silhouette (Figs 2 and 3).

At this time, diabetic ketoacidosis, emphysematous cystitis, tracking of gas along the caudoventral abdominal wall and suspected emphysematous endocarditis were diagnosed. The owner declined any

attempts at treatment but gave permission for a non-selective angiocardiology under general anaesthesia before euthanasia.

Angiocardiology revealed a well-defined, irregularly shaped space-occupying lesion of mixed soft tissue and gas opacity localised at the level of the tricuspid area, which moved with the heart cycle (Fig 4). The lesion was localised in the right atrium

during systole and in the right ventricle during diastole. The gas-containing cavitory lesion appeared to float against the cardiac free wall and to be attached to the septal cusp of tricuspid valve.

Post-mortem examination revealed vegetative endocarditis of the tricuspid valve, pyelonephritis, cystitis and bilateral adrenocortical hyperplasia. Microscopically, the thrombotic mass on the tricuspid valve consisted in fibrin proliferations with many Gram-negative as well as Gram-positive bacteria. Other findings included a smaller amount of round cell infiltrate, beginning proliferation of fibroblasts and capillaries. The mass also included optically free areas with bacterial populations. Bacterial culture of a tissue sample from the tricuspid valve revealed growth of *E coli*.



FIG 2. Abdominal radiograph showing gas accumulation in the bladder lumen, bladder wall and ventral abdominal wall

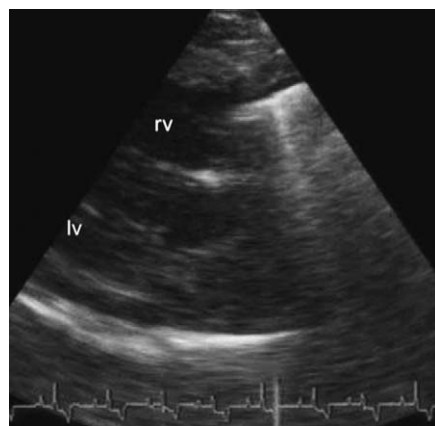


FIG 1. Echocardiographic picture, right parasternal location, longitudinal axis, four-chamber inflow view. Hyperechoic structure in the area of the tricuspid valve with distal reverberations. rv Right ventricle, lv Left ventricle



FIG 3. Thoracic radiograph showing gas accumulation in the area of the tricuspid valve

DISCUSSION

IE is a rare condition in dogs, with a prevalence of about 0.1 per cent of patients was presented to veterinary teaching hospitals (Sykes and others 2006). Previous reports of IE in dogs suggest a predilection for the aortic and mitral valves (Miller and Sisson 1999, Wall and others 2002, Sykes and others 2006). Most dogs had single valvular involvement (39 per cent mitral valve, 31 per cent aortic valve and 3 per cent tricuspid valve) and about 15 per cent were affected with both mitral and aortic valvular involvement (Sykes and others 2006). Larger breeds, including German shepherd dogs and Golden and labrador retrievers, appear to be predisposed (Wall and others

2002, Sykes and others 2006). Conditions suspected of predisposing dogs to IE include chronic subclinical prostatitis, immunosuppression and, possibly, subclinical subaortic stenosis in larger breeds of dogs (Wall and others 2002, Sykes and others 2006). In human beings, the tricuspid valve is most commonly affected by IE and predisposing factors include intravenous drug abuse, prosthetic valve implants, haemodialysis and right heart instrumentation (Peters 2005, Bashore and others 2006). In addition, abscess and fistula formation are described as a complication of IE in human beings with abscesses forming in the aortic root area as a result of cavitations of the aortic wall (Peters 2005). Rarely, these can erode into the pericardium or another heart chamber. One human case report describes intramyocardial gas accumulation because of myocardial infection caused by gas-producing *E coli* in a newly diagnosed diabetic patient (van der Vliet and others 2004).

The most frequent pathogens found in canine IE are streptococci and staphylococci, which together account for more than 50 per cent of all cases (Miller and Sisson 1999, Wall and others 2002, MacDonald and others 2004, Sykes and others 2006). Other bacteria described in canine IE include *E coli*, *Pasteurella* species, *Pseudomonas aeruginosa*, *Corynebacterium* species and, with increasing frequency, *Bartonella* species (Miller and Sisson 1999, Wall and others 2002, Sykes and others 2006). Similarly, in human beings, streptococci and staphylococci represent about 75 per cent of all cases (Peters 2005, Bashore and others 2006).

Emphysematous infection of the urinary tract (cystitis and pyelonephritis) as well as

hepatitis and pyometra are typical of gas-producing strains of *E coli*, *Clostridium* species, *Proteus mirabilis* and other Gram-negative bacilli and are often associated with diabetes mellitus and/or immune-compromised patients (Aizenberg and Aroch 2003, Petite and others 2006). The gas is thought to be mainly carbon dioxide and hydrogen, both fermentation products of glucose, albumin and tissue carbohydrates. Emphysematous cystitis in non-diabetic patients is often associated with glucosuria, immunosuppression and anatomic abnormalities of the lower urinary tract. However, to the authors' knowledge, gas-producing IE has not been previously described in animals or human beings.

The dog described in the current report had diabetes and a previous urinary tract infection and was therefore a risk patient for gas-producing infection of the urinary tract. In addition, the dog may have been predisposed to thrombus formation because she had had a central venous catheter during a 24 hour period one week before presentation for blood glucose monitoring, as well as a peripheral venous catheter during a 48 hour period and a 24 hour period, three weeks and four days before presentation, respectively. Given that IE was on the tricuspid valve, thromboembolus formation because of a venous catheter may have played a role in bacteraemic spread of infection to the heart. Based on angiography and the pathomorphologic examination, the gas in the right ventricle was not free, and therefore, entrapment of a gas pocket as a result of placement of the central venous catheter in the morning of presentation seems to be very unlikely.

This case demonstrates that gas-producing *E coli* can cause IE in dogs. Diabetes

mellitus and emphysematous cystitis are likely the underlying source of infection, and venous catheterisation may play a role in the spread of infection to the tricuspid valve.

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