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Hematological differentiation of bladder rupture and complete/partial urethral obstruction in castrated Hanwoo (Korean indigenous cattle) with urolithiasis

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ABSTRACT

This case report describes the hematological and radiological examination of urinary bladder rupture and complete urethral obstruction. associated with urolithiasis in Hanwoo. Hyponatremia, hypochloremia, azotemia, and hyperglycemia were observed in both urethral obstruction and urinary bladder rupture. However, cattle with urethral obstruction showed hyperkalemia and mild hyperglycemia, whereas cattle with bladder rupture showed marked hyperglycemia and normal potassium levels. In ultrasonography, the urethral obstruction showed a dilated bladder with a thick bladder wall. In contrast to previous literature, in this study, severe electrolyte changes such as severe hyponatremia, hypochloremia, and hyperkalemia occurred in a case of complete urethral obstruction.

Keywords: Bovine; urinary bladder; hyperkalemia; azotemia; ultrasonography

INTRODUCTION

Unlike monogastric animals, cattle urine is alkaline. Struvite (magnesium ammonium phosphate) and appitete (calcium phosphate) are known to precipitate well in alkaline urine [1]. In addition, high incidences of struvite and apatite have been reported in steers fed concentrate feeds. Urolith location, degree, and duration can cause urethral obstruction/rupture, urinary bladder rupture, and hydronephrosis [2]. Urolithiasis can cause obstruction and rupture of the lower urinary system (such as the bladder and urethra); therefore, complications due to urolithiasis can occur due to diseases secondary to urolithiasis rather than urolithiasis itself [3].

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Conflict of Interest

The authors declare no conflicts of interest.

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Urolithiasis shares symptoms with several other organ system diseases, such as obstruction of the gastrointestinal tract, umbilical hernia, and ascites [2,4]. Thus, urolithiasis must be differentiated from other diseases with similar symptoms using various diagnostic techniques, including physical examination methods like auscultation, percussion, rectal examination, radiography, and ultrasonography, and laboratory tests like blood gas analysis and serum chemistry tests [5].

More importantly, to determine the treatment method for urolithiasis (medical or surgical treatment), prognosis, and salvage, the patient's condition should be understood in detail using the tests listed above [6]. However, hematological and radiological examination results of urinary rupture and obstruction secondary to urolithiasis are rarely reported.

This study describes two cases of urinary bladder rupture and urethral obstruction due to urolithiasis in castrated Korean indigenous cattle (KIC) and compares the physical, rectal, ultrasound, serum chemistry, and blood gas examination results. It is believed that the results of this analysis can be used by large animal clinical veterinarians to diagnose and determine the status of patients with urolithiasis and set treatment and management guidelines.

CASE PRESENTATION

Case 1 was a 23-month-old castrated KIC with a urinary bladder rupture. During history-taking, the owner reported kicking pain in the abdomen with alternating signs of straining and non-straining episodes for one day. Physical examination revealed preputial stones, hematuria, and symmetrical sagging of the abdomen (**Supplementary Fig. 1A**). The degree of the sunken eye and the results of the skin tent test indicated dehydration of 10%. Ascites containing blood that smelled of urine were collected via abdominal paracentesis (**Supplementary Fig. 1B**), and the shape of a normal bladder was not found, and there was almost no anechoic fluid in the lumen on ultrasound examination. Based on the results of the physical examination, abdominal paracentesis, and ultrasonography, the patient was diagnosed with uroperitoneum secondary to urinary bladder rupture.

Serum chemistry analysis (SCA) and blood gas analysis (BGA) were performed. As a result, SCA revealed azotemia (creatinine 11.5 mg/dL, blood urea nitrogen [BUN] 97.5 mg/dL), hyperglycemia (279.5 mg/dL), and mild hyperphosphatemia (10.7 mg/dL) (**Fig. 1**). BGA revealed hyponatremia (121 mmol/L) and hypochloremia (85 mmol/L) were observed (**Table 1**).

Case 2 was a 24-month-old castrated KIC presenting with preputial stones, stranguria, and ruminal bloating as the chief complaints. Physical examination of the enophthalmos (sunken eye) and the results of a skin tent test showed dehydration of 8%, and the rectal temperature was 36.7°C, indicating hypothermia. The respiratory rate was 56 breaths/min, showing an elevation in the respiratory rate. A rectal examination revealed that the bladder was distended but that the left kidney was normal in size. Auscultation of the rumen revealed that ruminal contractions occurred approximately once every 3 minutes, indicating hypomotility of the rumen. As it was necessary in the first place to alleviate dyspnea due to ruminal bloat, decompression of the rumen was performed through the insertion of a stomach tube into the rumen. Ultrasound examination of the bladder through the rectum revealed a distended bladder full of stones (**Fig. 2A**), and urolithiasis in the right kidney and mild renal calices dilatation were detected on transcutaneous abdominal ultrasound (**Fig. 2B**). Based on the

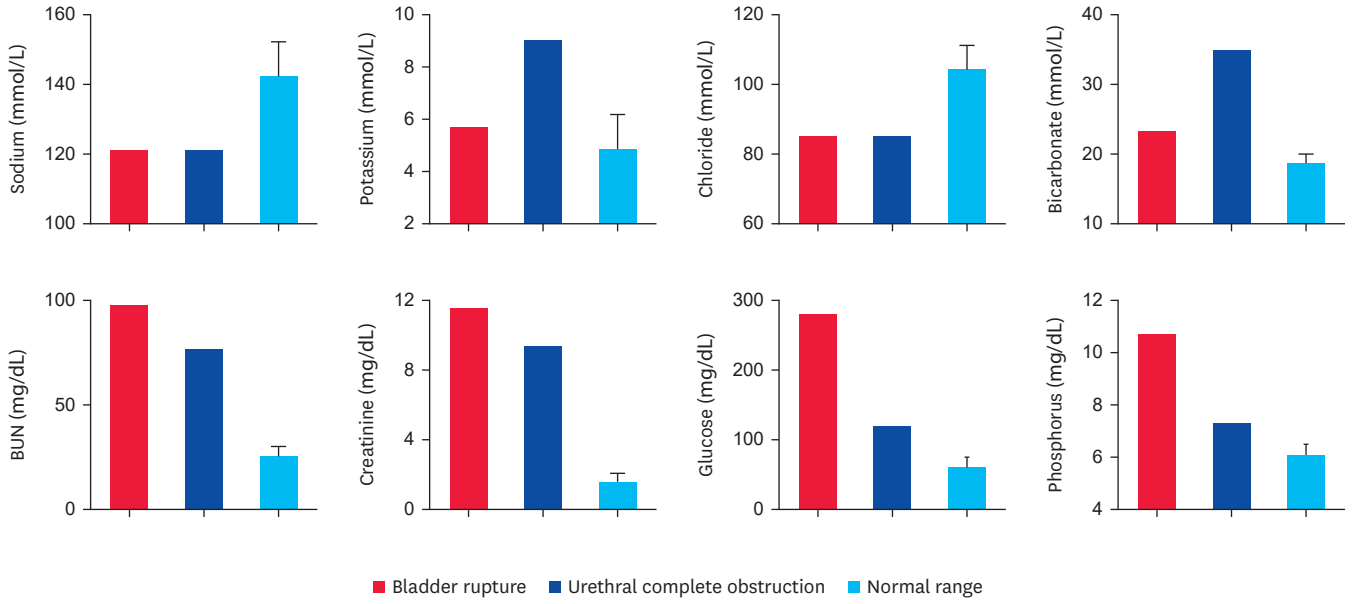

Fig. 1. Profiles of serum chemistry in bladder rupture (Case 1) and complete urethral obstruction (Case 2).
BUN, blood urea nitrogen.

Table 1. Profiles of blood gas analysis on bladder rupture and complete/partial urethral obstruction cattle

Parameter	Case 1	Case 2	Reference
	Bladder rupture	Urethral complete obstruction	(Normal range)
Blood gas analysis			
Sodium (mmol/L)	121	121	132–152
Potassium (mmol/L)	5.7	> 9.0	3.9–5.8
Chloride (mmol/L)	85	85	97–111
Bicarbonate (mmol/L)	23.3	35.0	17–20
Calcium (mg/dL)	8.9	8	9.7–12.4
tCO_2 (mmol/L)	24	37	21–32
pCO_2 (mmHg)	30.8	79.5	35–44
pH	7.49	7.25	7.3–7.5
Hct (%)	45	50	22–33
Anion gap (mmol/L)	19	21	14–20

tCO_2, total carbon dioxide; pCO_2, partial pressure of carbon dioxide; Hct, hematocrit.

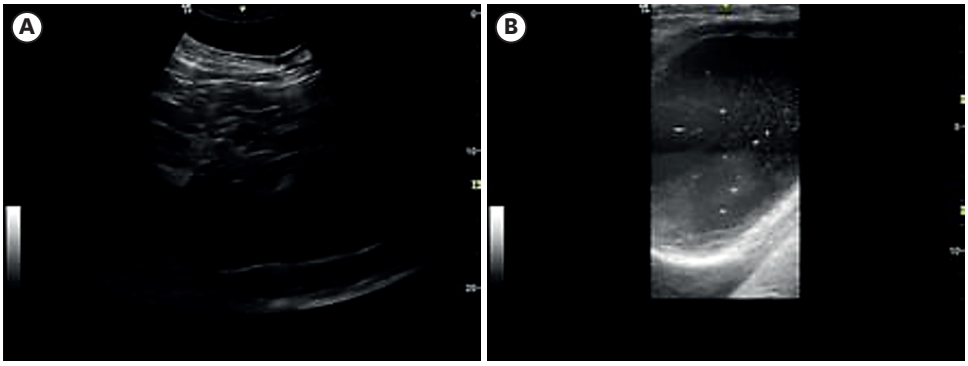

Fig. 2. Ultrasonography results of the kidneys and bladder of a cattle with urethral obstruction. Renal calices were dilated and filled with materials as seen on trans-abdominal ultrasonography examination (A). Urinary bladder was dilated with hyperechogenic materials. Walls of urinary bladder were also thickened (B).

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results of the physical examination and ultrasonography, the patient was diagnosed with urethral obstruction.

BGA revealed hyponatremia (121 mmol/L), hypochloremia (85 mmol/L), and marked hyperkalemia (9 mmol/L) (**Table 1**). Moreover, there was a slight decrease in calcium levels and an increase in potassium levels (**Table 1**). Ruminal bloating and dyspnea due to the enlarged rumen were also detected. Additionally, BGA revealed respiratory acidosis due to these causes. On SCA, the creatinine was 9.3 mg/dL and the BUN was 76.4 mg/dL, indicating azotemia. Additionally, the blood glucose level was 119.7 mg/dL, indicating hyperglycemia (**Fig. 1**).

In Case 2, urethral obstruction at a point after the bladder in the urinary tract was suspected based on the dilated bladder, thickened bladder walls, and hyperechogenic materials presumed to be stones in the urinary bladder. Based on the results of SCA and BGA, the patient was diagnosed with urethral obstruction. Regarding the diagnosis of urethral obstruction in cattle, it is thought that the diagnosis can be made only using a combination of diagnostic methods, including physical examination, ultrasonography, SCA, and BGA.

DISCUSSION

Urinary bladder rupture in cattle causes hematologic changes, including a decrease in serum sodium and chloride and an increase in serum potassium, BUN, creatinine, and phosphorus [2,7]. In Case 1, a decrease in sodium and chloride levels and an elevation in BUN, creatinine, and phosphorus levels were observed; however, the potassium level was normal. This normal potassium level can be attributed to increased salivary potassium loss due to hyponatremia and decreased potassium intake due to anorexia. Additionally, there was a slight decrease in calcium level, which is thought to be due to anorexia and the competitive effect of hyperphosphatemia [2].

It has been reported that hyponatremia, hypochloremia, hypocalcemia, hyperphosphatemia, and marked azotemia may develop from urethral obstruction [2,8,9]. Consistent with previous findings, in Case 2, hyponatremia, hypochloremia, hypocalcemia, and azotemia were observed, but hypocalcemia and hyperphosphatemia were not detected. The most common site of urethral obstruction is the sigmoid flexure, which is not readily accessible for palpation or ultrasound examination [7].

Urethral obstruction can be chronic or acute. Acute urethral obstruction may cause prerenal azotemia by reducing water intake as well as acute urethral obstruction. Postrenal azotemia is suspected in chronic urethral obstruction due to decreased water intake. Consequently, chronic urethral obstruction may be accompanied by hypocalcemia and hyperkalemia. Confirming this expectation, in the urethral obstruction case in this study, hyperkalemia and mild hypocalcemia were observed, which are thought to result from renal damage due to chronic urethral obstruction. Therefore, if a chronic urethral obstruction is suspected, observation of kidney lesions by ultrasonography may help determine the prognosis and treatment method [10].

Both cases of urinary bladder rupture and urethral obstruction showed hyperglycemia, and the blood glucose level was higher in the case of bladder rupture (279.54 mg/dL) than in the case of urethral obstruction (119.7 mg/dL). Hyperglycemia has been reported in patients with postrenal

azotemia secondary to urolithiasis due to glucose intolerance and stress associated with azotemia [2]. Thus, follow-up studies regarding hyperglycemia occurring in cases of urethral obstruction, urethral rupture, and bladder rupture secondary to urolithiasis are needed.

In urethral obstruction, phosphorous levels were normal, but urinary bladder rupture caused moderate hyperphosphatemia. Abomasal displacement and volvulus associated with dehydration can cause hyperphosphatemia in cattle [11]. In this report, dehydration was present in both the urinary bladder rupture and urethral obstruction cases, but the steer with urinary bladder rupture showed more severe dehydration. Additionally, in cases of urinary bladder rupture, diffusion from the urine to the extracellular fluid and degradation of intracellular organophosphate due to tissue hypoxia are presumed to be factors associated with hyperphosphatemia [2,12].

In contrast, in our previous cases of five castrated KICs with partial urethral obstruction, BGA did not show electrolyte abnormalities or increases in BUN or glucose levels, although clinical signs of abdominal pain such as kicking the abdomen, tenesmus, and a dry, stone-hanging preputial tuft were observed (unpublished data). In addition, patients with partial urethral obstruction were injected with Acepromazine Maleate (5 mg/100 kg) intravenously, followed by a 1–2 L normal physiological saline infusion. Urination was confirmed using fluid therapy, and a good prognosis was observed even after an additional 2–3 days of observation (unpublished data). In cases of urethrolithiasis, urethral rupture or partial/complete urethral obstruction can be identified. However, palpation and ultrasonography of the urethra in the sigmoid flexure in cattle older than 18 months of age are very difficult. Therefore, as in bladder rupture, it is necessary to first determine the prognosis after examining urethral rupture and partial or complete urethral obstruction through diagnostic medical treatment, along with BGA and SCA.

Urolithiasis is clinically important because it can cause urinary tract rupture or renal failure, rather than itself. In particular, the literature has focused on bladder or urethral rupture. Donecker and Bellamy [7] compared BGA and SBA for bladder rupture (n = 13) and urethral rupture (n = 6) in steers. Sokett et al. [13] observed changes in BGA and SBA by experimentally causing bladder rupture (n = 5) in yearling steers. The reports by Donecker and Bellamy and Sokett et al. [13] showed hyponatremia, hypochloremia, and hyperzotemia in the same way as in the ruptured bladder case of Hanwoo steers. George et al. [14] compared BGA and SBA in goats with urolithiasis (n = 107) and controls (n = 94). In contrast to previous reports in cattle, hypophosphatemia was notably observed. BGA and SCA of bladder rupture and urethral rupture were compared in goats, but no comparison was made for disease severity. Abdalla et al. [15] compared BGA and SCA in intact (n = 8) and ruptured (n = 6) bladders secondary to urolithiasis in calves. Based on the previous literature reports, we found that BGA and SCA values were more variable in the order of urethral obstruction, urethral rupture, and bladder rupture.

In our case, we found that the changes in BGA and SCA levels worsened in the order of partial urethral obstruction, complete urethral obstruction, and bladder rupture. However, the changes in sodium, chloride, and potassium in complete urethral obstruction were similar in magnitude compared to bladder rupture. In particular, an increase in potassium concentration was characterized. In other words, renal function abnormalities due to complete urethral obstruction may also occur with more than moderate severity. Unlike previous studies that focused on bladder rupture or urethral rupture, these findings highlight

that complete urethral obstruction can cause more than just urinary tract rupture but can result in lethal renal dysfunction in cattle.

Potential limitations of this case report, limited numbers of case were enrolled in the study. The findings of this case report would be the fundamental data for the future large-scale study for investigating the clinical and biochemical data in various urinary diseases.

Treatment of urolithiasis in cattle is possible with medical treatment in cases of partial urethral obstruction. However, complete urethral obstruction or urinary tract rupture requires surgical intervention. However, considering the size of the cattle, the location of the organs, and their economic feasibility as industrial animals, it is reasonable to slaughter them before renal dysfunction or urinary system rupture occurs. Perineal urethrostomy is a temporary measure for slaughter, while tube cystotomy is inaccessible in beef steers due to the size of the cattle and the volume of the rumen and may be rejected by farmers due to cost. Utilizing BGA and SCA in conjunction with physical examination and ultrasonography will aid in the diagnosis of urethral obstruction, urethral rupture, and bladder rupture and will further guide the bovine practitioner's decision on whether to treat or slaughter.

SUPPLEMENTARY MATERIAL

Supplementary Fig. 1

Clinical features of the Case 1. On physical examination, preputial stone (A). Ascites containing blood were collected by abdominal paracentesis (B).

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