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Case Report – Urinary Bladder Rupture, Urolithiasis, and Azotemia in a Brangus Bull: a Herd Approach

P. Melendez*, *DVM, MS, PhD;* **O. Rae,** *DVM, MPVM;* **C. Risco,** *DVM, Dip. ACT*
Food Animal Reproduction and Medicine Service, Department of Large Animal Clinical Sciences, College of Veterinary Medicine, University of Florida, Gainesville, FL 32610
** Corresponding author*

Abstract

An obese four-year-old Brangus bull was presented with a swollen protruding penis and enlarged pendulous abdomen. Azotemia, urinary bladder rupture and urolithiasis were diagnosed; the bull was euthanized. Calculi were composed of magnesium ammonium phosphate (struvite). A later visit to the ranch found that bulls were overfed concentrate ration, magnesium and phosphorus. Nutritional changes were recommended, and no further cases of urolithiaisis were reported.

Keywords: bovine, beef cattle, urolithiasis, struvite, urinary bladder rupture, azotemia, bull

Résumé

Un taureau Brangus obèse de quatre ans a été admis avec un pénis protubérant enflé et un abdomen pendant dilaté. On a diagnostiqué l'azotémie, une rupture de la vessie urinaire et l'urolithiase. Le taureau a été euthanasié. Les calculs étaient composés de phosphate de magnésium ammonium (struvites). Une visite subséquente au ranch indiqua que les taureaux étaient suralimentés avec une ration concentrée, du magnésium et du phosphore. Des changements nutritionnels ont été recommandés et aucun autre cas d'urolithiase n'a été rapporté.

Introduction

Urolithiasis is a metabolic disease affecting cattle, sheep and goats.[14] It refers to formation of stone-like structures (calculi) inside the urinary tract as a result of mineral precipitation.[8] Calculi may or may not obstruct the urinary tract, but when they are obstructive, urinary bladder rupture may occur.[15] Urolithiasis is the most important urinary tract disease in feedlot and range cattle, especially in castrated males from six to 24 months of age. It is less common in dairy cattle.[11,14] Urolithiasis in intact males (beef bulls) is less common than in castrated males because early castration contributes to a reduced diameter of the urethra.[11] Formation of urinary calculi is a multifactorial condition involving physiological, nutritional and managerial variables.[5] Imbalances of mineral intake have been identified as causes of urolithiasis.[9] Excesses of phosphorus and magnesium are predisposing factors of phosphatic urolithiasis or "struvite" (magnesium ammonium phosphate) calculi; therefore, rations high in grain and protein, low water intake and urine alkalinity have also been related to this condition.[4] In beef feedlots, death losses due to phosphatic urolithiasis have been estimated at 0.6%; therefore, feeding management practices are important for prevention of this condition.[14] Silica urolithiasis is common in cattle and sheep grazing many areas in the western United States due to the high silica content of some pastures, especially as plants mature.[14]

Urolith formation with obstruction of the urethra is more common in steers, breeding and castrated rams, and goats.[10] Urinary bladder and urethral rupture is a sequel to urethra obstruction.[10,11] Few cases of urinary bladder rupture have been reported in female cattle. One case was observed in a yearling Holstein heifer, perhaps related to urachal abscessation.[12] Another case was reported in a post-partum two-year-old Angus cow.[13] Urethral rupture has been reported in steers and bulls.[14] Examination of records for an 11-year period reported 76 steers with a ruptured urethra (10.5% fatality rate) and 59 steers with a ruptured bladder (50.8% fatality rate).[2]

In the following report, a case of urolithiasis and urinary bladder rupture in a valuable, high-genetic merit Brangus bull is presented. In a follow-up of the case, on-farm nutritional consultation was conducted to evaluate the feeding management of the herd in order to avoid additional cases and economic losses.

History

A four-year-old, high-genetic merit Brangus bull ("Decade") with an obese body condition score (BCS) of

8 (scale 1 to 9, 1 being extremely thin and 9 extremely obese), swollen protruding penis and enlarged, pendulous abdomen was presented to the Veterinary Medical Center (VMC), College of Veterinary Medicine, University of Florida (UF) on January 17, 2004.

The bull was purchased from a Texas purebred cattle ranch at one year of age and had been at the current Florida ranch for three years with no history of health problems. There were 450 Brangus cows, 30 Brangus bulls ranging in age from 15 months to two years of age and 20 bulls over two years of age on the 1000-acre ranch. The owner historically sold purebred registered heifers and young bulls for breeding purposes.

Before the problem was noticed, the bull had been grazing a Bahia grass (*Paspalum notatum*) pasture with mature breeding cows. On January 16, the bull was seen with a swollen, protruding penis and enlarged abdomen. The animal was removed from the pasture and placed in an individual pen for observation. Because of no improvement in the bull's condition over the next 24 hours, the owner transported the bull to the VMC, UF.

Clinical Findings

On inspection, the bull was depressed and had an enlarged ventral abdomen, scrotum and penile area. The bull was obese with a body condition score of 8.0 and weighed approximately 2200 lb (1000 kg).

Physical examination findings included a rectal temperature 103.4°F (39.3°C), heart rate of 75 beats per minute and a respiratory rate of 48 breaths per minute. Lungs were auscultated and found normal. Rumen contractions occurred at one to two minute intervals and were weak. The bull was estimated to be dehydrated 4% based on a skin turgor test of about three seconds duration at the level of the neck. Enlarged internal iliac lymph nodes and fluid-filled abdominal cavity were found during rectal palpation. Based on physical examination, the differential diagnosis included ascites and peritonitis. Uroperitoneum was not considered as a differential diagnosis at that time.

Diagnostic Laboratory Findings and Interpretation

A blood sample for CBC and chemistry panel was obtained from the coccygeal vein; results are shown in Table 1. Red blood cell parameters were within normal limits; however, white blood cells showed abnormal values. The sample revealed neutrophilia (6.6 x $10^3/\mu L$; normal range 0.6-4 x $10^3/\mu L$) and lymphopenia (1.9 x $10^3/\mu L$; normal range 2.5-7.5 x $10^3/\mu L$) with a neutrophil:lymphocyte ratio of 3.47 (normal range 0.3-0.6). These results were characteristic of septicemia or toxemia.[6]

The chemistry panel revealed elevated levels of blood urea nitrogen (184 mg/dL; normal range 20-30 mg/dL) and creatinine (31.4 mg/dL; normal range 1-2 mg/dL). In addition, there was mild hyponatremia (124 mEq/L; normal range 132-152 mEq/L) and marked hypochloremia (69 mEq/L; normal range 97-111 mEq/L), mild hyperkalemia (6.2 mEq/L; normal range 3.9-5.8 mEq/L) and increased anion gap (27 mEq/L; normal range 14-20 mEq/L). Phosphorus, magnesium, total protein, fibrinogen, alkaline phosphatase and aspartate amino transferase were also elevated (Table 1). Based on the extremely high concentration of blood urea nitrogen and creatinine, azotemia was diagnosed; however, whether the condition was prerenal, renal or postrenal was still unresolved.

Ultrasound examination demonstrated a significant amount of fluid in the abdominal cavity (Figure 1). Abdominal paracentesis was conducted on the same day (January 17), and about 5 mL of hazy, reddish fluid was obtained. Fluid analysis showed a protein level of 2.0 g/dL, a RBC of 390,000/μL and a WBC of 920/μL (49% neutrophils, 24% lymphocytes, 27% mononuclear phagocytes). Results of the fluid analysis were interpreted as a transudate. Based on the clinical findings, azotemia, hyponatremia, hypochloremia, hyperkalemia and hyperphosphatemia, plus an elevated anion gap, enlarged abdominal cavity, enormous amount of abdominal fluid identified on ultrasound examination and at rectal palpation, the most likely diagnosis was urinary bladder rupture with uroperitoneum and renal failure. Based on these conclusions, an exploratory laparotomy was performed three hours after arrival at the hospital.

Surgical Findings

The exploratory laparotomy was performed using a right paralumbar fossa approach. Upon opening the abdominal cavity, approximately 20 gallons of urine-like fluid was released. Manual exploration of the abdomen revealed a contracted, ruptured urinary bladder. The rupture was located on the dorsum of the bladder and was approximately 5 inches (13 cm) in length. It was possible to introduce the entire hand into the bladder. About 25 solid structures (stones) of different diameters (2 to 10 mm) were recovered (Figure 2). A final diagnosis of uroperitoneum as a result of urinary bladder rupture caused by urolithiasis and urethral obstruction was established.

Case Management

Because of the high economic value of this bull, closure of the urinary bladder was attempted. A Cushing suture pattern using catgut chromic USP 2.0 (Metric 6.0) was used to successfully close the defect. Approximately 100 mL of Penicillin G procaine (300,000 IU/ml)

Table 1. Results of CBC and blood chemistry for an adult Brangus bull with urolithiasis.

Item	Jan. 17	Jan. 20	Jan. 22	Normal range
PCV (%)	30	-	-	26-42
Erythrocytes (x 10^6/μL)	6.06	-	-	5.0-8.0
Hemoglobin (g/dL)	10.6	-	-	8.0-14.0
White blood cells (x 10^3/μL)	8.91	-	-	4.0-12.0
Neutrophils (x 10^3/μL)	6.6	-	-	0.6-4.0
Lymphocytes (x 10^3/μL)	1.9	-	-	2.5-7.5
Monocytes (x 10^3/μL)	0.36	-	-	0.1-1.5
Platelet (x 10^3/μL)	412	-	-	175-620
Total bilirubin (mg/dL)	0.2	0.5	0.1	0.01-0.47
Creatinine (mg/dL)	31.4	34.4	12.0	1-2
Glucose (mg/dL)	75	68	25	45-75
Fibrinogen (mg/dL)	700	-	-	200-500
Total protein (g/dL)	10.6	10.8	7.0	6.7-7.5
Albumin (g/dL)	3.1	3.1	2.3	3.0-3.6
A/G ratio	0.4	0.4	0.5	0.8-0.9
Globulin (g/dL)	7.5	7.7	4.7	3.0-3.5
Urea nitrogen (mg/dL)	184	208	118	20-30
Sodium (mEq/L)	124	115	131	132-152
Potassium (mEq/L)	6.2	5.8	5.3	3.9-5.8
Chloride (mEq/L)	69	60	83	97-111
Calcium (mg/dL)	8.0	7.4	8.0	9.7-12.4
Phosphorus (mg/dL)	8.2	17.5	9.4	5.6-6.5
Magnesium (mg/dL)	6.8	4.7	2.6	1.8-2.3
Anion gap (mEq/L)	27	38	26	14-20
Carbon dioxide (mEq/L)	34	29	27	21-32
Alkaline phosphatase (U/L)	112	134	82	27-107
Activated AST (IU/L)	199	512	328	43-127
Gamma GT (U/L)	35	36	47	15-39

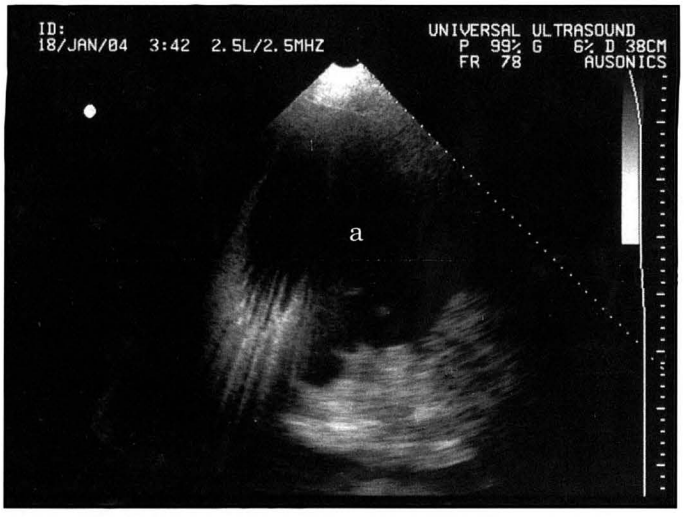

Figure 1. Ultrasound findings of the abdominal cavity of the bull with a ruptured urinary bladder and azotemia due to urolithiasis. Notice (a) the amount of fluid present in the cavity.

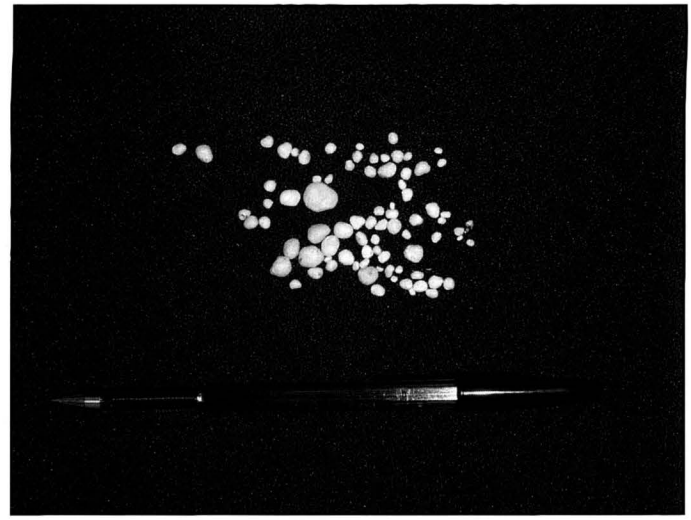

Figure 2. Magnesium ammonium phosphate (struvite) calculi found inside the ruptured urinary bladder of a Brangus bull ("Decade").

was placed into the abdominal cavity, and about a one-gallon mix of Ringer's lactate (2 liters) and 0.9% NaCl (2 liters) was administered IV at a rate of 4 mL/kg/hour. After surgery, alfalfa hay, sweet feed and free choice water was offered. Subsequently, obstruction of the urethra was addressed. During the same day, epidural anesthesia (6 mL of 2% lidocaine) was performed between the first and second coccygeal vertebrae subsequent to clipping and disinfecting the area, and a perineal ureterotomy was performed. The perineal incision was made approximately 5.9 inches (15 cm) ventral to the anus. Elastic and fat tissue was debrided until the penis was localized. A longitudinal incision was performed on the penile tissue until the urethra was identified and opened. A polyethylene urethral catheter 23.6 inches (60 cm) in length and 0.2 inch (5 mm) in diameter with a rounded tip was guided with a metal artificial insemination stile and introduced towards the urinary bladder. However, entry into the urinary bladder was not accomplished. The urethral catheter was then directed towards the sigmoid flexure to remove potential calculi in the penile urethra. This procedure was also unsuccessful. The following day (January 18), an attempt to unblock the urethra, using the same procedure described above, failed a second time. The remaining solution to avoid urinary bladder rupture was to perform a perineal urethrostomy; however, this technique would result in permanent infertility. Although a perineal urethrostomy was performed and the obstruction was resolved, the owner elected to euthanize the animal. The bull was euthanized on January 21.

Calculi were submitted to the Urolithiasis and Urochemistry Laboratories (Houston, TX 77265-5375) for chemical analysis. Analysis of the stones revealed a composition of 95% magnesium ammonium phosphate (struvite) and 5% calcium phosphate (apatite). Because struvite calculi are associated with high dietary phosphorus and magnesium levels, as well as feeding high levels of pelleted ration with resultant low saliva production, the owner requested a consultation visit to his ranch to determine if other bulls might be at risk of urolithiasis.

Consulting Visit to the Ranch

The ranch, located in central Florida, was visited on January 30, 2004. The ranch consisted of 1000 acres, divided into 15 different pastures. Bahia grass (*Paspalum notatum*) was the primary forage on the ranch. Pastures were fertilized annually, and produced an estimated 11,000 lb (5,000 kg) of dry matter per acre each year. Hay was harvested during the peak growing season and stockpiled to supplement the herd during the winter (November to February). About 100 acres was planted with ryegrass for winter grazing (*Lolium spp*). This pasture was grazed by the bulls during winter.

The cow-herd consisted of 450 Brangus cows divided into two groups of about 338 mature pregnant cows and 112 pregnant heifers (22-24 months of age) in the last trimester of gestation. Twenty mature bulls were kept separate in a small Bahia grass pasture. A group of 90 heifers 12 to 15 months of age, 15 young bulls 12 to 15 months of age and 15 young bulls from 24 to 27 months of age were raised in small, separate ryegrass pastures. Mature cows and pregnant heifers were supplemented with concentrate ration at 3 lb (1.36 kg)/head/day. Mature bulls received 5 lb (2.27 kg)/head/day, while young bulls were fed concentrate *ad libitum*.

Based on accessibility of animals, a sub-sample of six young bulls (12 to 15 months of age, BCS 8 to 9) and five mature cows (4 to 6 years-old, BCS 5 to 7) were presented for diagnostic work-up. Blood and urine samples were collected for serum chemistry and urine pH analysis, respectively (Tables 2 and 3). Samples were collected from four bulls and three cows for blood chemistries, and urine was collected from all six bulls and three cows for pH determination. All young bulls and mature cows tested had low concentrations of blood urea nitrogen (< 10 mg/dl; normal range 20 to 30 mg/dl), and all bulls and two of three cows had high levels of phosphorus (> 7.5 mg/dl; normal range 5.6-6.5 mg/dl). In general, other chemistries were within normal ranges. Unlike the bulls, cows were not excessively obese (BCS 5 to 7) and were representative of other cows in the herd.

Samples of concentrate ration and pasture forages fed to bulls were taken for nutritional analysis (Tables 4 and 5). Cow pastures were also analyzed (Table 6). Samples were submitted to the Dairy One Forage Laboratory (Ithaca, NY 14850) for nutritional analysis. As Table 4 shows, excessive levels of crude protein, P, Mg, K and Na were found in the concentrate ration. As shown in Tables 5 and 6, ryegrass pasture (for bulls) contained large amounts of crude protein, P and K, but was low in Na. Bahia grass forage (for cows) contained less crude protein, P and K than forage from bull pastures.

Because cow nutritional management seemed adequate, no changes were recommended. For the young bulls, we recommended that concentrate ration be fed at 8 lb (3.6 kg) per head per day, feeding half in the morning and the remaining half in the afternoon. Concentrate ration was fed in a metal feed bunk located in the middle of the pasture, with 20 inches (50.8 cm) of bunk space per head. Free-choice hay, water and pasture were also recommended. After the changes were made, no more cases of urolithiasis were reported.

Discussion

Individual case

"Decade" was an extremely valuable bull whose medical condition was seriously compromised when pre-

Table 2. Blood chemistry and urine pH of six randomly selected bulls from the client's beef cattle ranch.

Test	Bull identification						Normal range[1]
	55N	15N	33N	51N	70N	10N	
Alk phos (IU/L)	-	158	152	296	207	-	27-107
AST (IU/L)	-	94	125	94	93	-	43-127
TBili (mg/dl)	-	0.1	0.1	0.1	0.1	-	0.01-0.47
Total protein (g/dl)	-	7	5.9	6.5	6.5	-	6.7-7.5
Albumin (g/dl)	-	3.3	3.1	3.2	3.1	-	3.0-3.6
A/G ratio	-	0.9	1.1	1.0	0.9	-	0.8-0.9
Glob (g/dl)	-	3.7	2.8	3.3	3.4	-	3.0-3.5
Ca (mg/dl)	-	10.7	10.6	10.8	10.1	-	9.7-12.4
P (mg/dl)	-	9	8.3	8.4	8.6	-	5.6-6.5
Creatinine (mg/dl)	-	1.6	1.5	1.3	1.5	-	1-2
BUN (mg/dl)	-	2	8	4	7	-	20-30
Glucose (mg/dl)	-	58	67	65	73	-	45-75
Mg (mg/dl)	-	2.4	2.3	2.0	2.3	-	1.8-2.3
GGT (IU/L)	-	20	44	25	23	-	15-39
Na (mEq/L)	-	142	144	144	145	-	132-152
K (mEq/L)	-	6.1	6.1	5.2	6	-	3.9-5.8
Cl (mEq/L)	-	97	99	96	97	-	97-111
CO2 (mEq/L)	-	39	35	37	37	-	21-32
Anion gap (mEq/L)	-	12	16	16	17	-	14-20
Urine pH	7.0	8.0	7.5	8.0	8.0	7.5	7.5-8.5

Table 3. Blood chemistry analysis of three mature cows from the beef cattle ranch.

Test	Cow 302-G4	Cow 789-G	Cow 392	Normal range[1]
Alk phos (IU/L)	44	175	53	27-107
AST (IU/L)	138	95	105	43-127
TBili (mg/dl)	0.3	0.1	0.3	0.01-0.47
Total protein (g/dl)	8.0	6.7	7.0	6.7-7.5
Albumin (g/dl)	3.2	3.2	3.1	3.0-3.6
A/G ratio	0.7	0.9	0.8	0.8-0.9
Glob (g/dl)	4.8	3.5	3.9	3.0-3.5
Ca (mg/dl)	8.5	10.2	9.2	9.7-12.4
P (mg/dl)	7.5	7.7	5.9	5.6-6.5
Creatinine (mg/dl)	1.3	1.2	2.3	1-2
BUN (mg/dl)	9.0	7.0	9.0	20-30
Glucose (mg/dl)	50	52	50	45-75
Mg (mg/dl)	3.0	1.9	2.1	1.8-2.3
GGT (IU/L)	28	39	23	15-39
Na (mEq/L)	140	145	144	132-152
K (mEq/L)	4.9	4.6	4.6	3.9-5.8
Cl (mEq/L)	100	99	102	97-111
CO2 (mEq/L)	27	26	32	21-32
Anion gap (mEq/L)	18	25	15	14-20
Urine pH	-	8.5	8.5	7.5-8.5

Table 4. Formula and nutritional analysis of the concentrate fed to the bulls at the client's beef cattle ranch.

Components	Analysis, dry matter basis	Expected values *
Dry matter (%)	89.7	87.7
Crude protein (%)	13.7	12.2
Acid detergent fiber (%)	20.6	13.7
Neutral detergent fiber (%)	38.3	37.0
% TDN	75	70.4
NEM (Mcal/lb)	0.81	0.72
NEG (Mcal/lb)	0.53	0.74
Calcium %	1.14	0.98
Phosphorus %	0.60	0.45
Magnesium %	0.47	0.30
Potassium %	1.00	0.84
Sodium %	0.62	0.49
Iron ppm	423	-
Zinc ppm	174	-
Copper ppm	48	-
Manganese ppm	163	-

* Expected values from farm nutritionist diet formulation

Table 5. Nutritional analysis of forages from young bull pastures at the client's beef cattle ranch.

Components	Analysis, dry matter basis
Dry matter (%)	14.1
Crude protein (%)	35.9
Acid detergent fiber (%)	25.8
Neutral detergent fiber (%)	33.6
% TDN	70
NE maintenance (Mcal/lb)	0.73
NE gaining (Mcal/lb)	0.45
Calcium %	0.4
Phosphorus %	0.93
Magnesium %	0.26
Potassium %	5.76
Sodium %	0.014
Iron ppm	205
Zinc ppm	48
Copper ppm	7
Manganese ppm	93
Molybdenum ppm	0.2

Table 6. Nutritional analysis of forage samples in the cow pastures at the client's beef cattle ranch.

Components	Pasture 1	Pasture 2
Dry matter (%)	49.6	58.4
Crude protein (%)	11.5	12.0
Acid detergent fiber (%)	45.2	41.8
Neutral detergent fiber (%)	72.2	73.1
% TDN	59	59
NE maintenance (Mcal/lb)	0.52	0.52
NE gaining (Mcal/lb)	0.27	0.27
Calcium %	0.38	0.55
Phosphorus %	0.23	0.22
Magnesium %	0.29	0.26
Potassium %	0.94	0.69
Sodium %	0.017	0.003
Iron ppm	405	373
Zinc ppm	23	29
Copper ppm	9	6
Manganese ppm	71	245
Molybdenum ppm	0.4	0.3

sented to the VMC, UF. After CBC and chemistry panel interpretation, azotemia was diagnosed. Initially it was unknown whether the azotemia was prerenal, renal or postrenal. The importance of knowing the origin of azotemia is related to the therapeutic approach and the prognosis of the case. Urinalysis can be used to determine the type of azotemia. With prerenal azotemia, urine specific gravity is typically increased (1.050 or more) because the condition is associated with decreased blood flow through the kidney secondary to dehydration and/or cardiovascular insufficiency. A specific gravity less than 1.020 accompanied by dehydration is suggestive of renal failure, because the kidney is unable to concentrate urine. In addition, proteinuria may be present in the absence of bacteria, leukocytes and red blood cells.[1] Unfortunately, collection of a urine sample was not feasible in this case because the urinary bladder had ruptured and the urethra was obstructed. Furthermore, because urine usually has a lower concentration of sodium and chloride and higher concentrations of urea, creatinine, potassium and phosphate than plasma, diffusion along these concentration gradients across the peritoneal membrane results in a general pattern of azotemia with hyponatremia, hypochloremia, hyperkalemia, hyperphosphatemia and increased anion gap.[1,10] Results of the chemistry panel conducted prior to surgery (Table 1) showed hyponatremia, hypochloremia, hyperkalemia, and elevated phosphorus and anion gap. These results are in agreement with an earlier report on blood chemical abnormalities in cattle with ruptured urinary bladders over a period of 11 years (59 cases). In that study, serum phosphate was the best prognostic indicator because all fatal cases had a serum phosphate level above 8.98 mg/dl.[2]

Although the success rate of laparotomy and primary repair of the urinary bladder in cattle has been reported to be between 55 and 71%,[14] urethral obstruction in this case was not medically and surgically resolved. Urethrotomy was elected to unblock the urethra without impairing fertility of the bull; however, extreme obesity made surgery difficult to perform. Unfortunately, there are few reports on the success of urethrotomy. Further, urethral stricture and re-obstruction with additional calculi have been described.[14] In the end, a urethrostomy was performed in an attempt to unblock the urethra; however, the owner was aware this procedure would result in infertility. Shortly after resection of the penis was conducted, euthanasia was elected.

Herd approach

Alkaline phosphatase was elevated in the four bulls sampled. Since this enzyme is not organ-specific in cattle, it is necessary to interpret it based on other biochemical indicators.[1] This increase was most likely related to growth of these young bulls as alkaline phosphatatse is released by osteoblasts from metabolically active bones. It can also be elevated due to liver failure, rickets and healing fractures,[1] but there were no signs of hepatic compromise, calcium deficiency or history of bone disease in these animals. Other indicators of liver damage, such as GGT, albumin and globulins, were within normal limits; however, AST was elevated.

Serum phosphorus was elevated in all bulls and in two of three cows sampled. High levels of phosphorus

can be related to growth of animals (7-9 mg/dL). In addition, hyperphosphatemia can be related to acute renal failure, excess phosphate intake, vitamin D toxicity and acute rhabdomyolysis.[1] In the present case, the most likely cause of high levels of serum phosphorus was the stage of growth of the young bulls, and excessive phosphate intake due to high levels of P in both the concentrate ration and the ryegrass pasture. Dietary phosphorus levels for beef cattle should not exceed 0.38% of the ration on a dry matter basis;[7] however, the concentrate diet and pasture fed to these young bulls contained excessive levels of P (≥ 0.6%).

Magnesium levels were near the upper limit of normal values. Hypomagnesemia in cattle is relatively common (< 1.8 mg/dL) and is frequently called grass tetany. Hypermagnesemia, however, is unusual and most likely explained by high intake of this mineral.[4,7,9] Magnesium in rations for adult and young beef cattle should not exceed 0.20% (dry matter basis).[7] The concentrate diet and forages fed to the bulls contained more than 0.25% Mg; therefore, they were consuming excessive quantities.

Blood urea nitrogen was markedly below normal. This is usually due to consuming a low protein diet or liver failure.[1] There was no indication of hepatic dysfunction, leaving us with no explanation for this inconsistency. Urine pH was typical for cattle. Alkaline urine favors the formation of struvite uroliths (magnesium ammonium phosphate).[14]

In general, analysis of the concentrate diet was in agreement with values calculated by the nutritionist (Table 4); however, phosphorus, magnesium, potassium and sodium exceeded the expected values. The requirement for magnesium in growing beef cattle is 0.1% (dry matter basis), with a maximum tolerable level of 0.4%.[7]

Based on the analyses of forages grazed by the bull (Table 5), those forages were typical of lush pastures with a high potassium and crude protein content. Considering the high levels of crude protein in the ryegrass pasture and the protein level in the concentrate that was fed (~ 14%; Table 4), bulls were consuming more than NRC recommendations,[7] but this did not result in higher blood urea nitrogen levels, which were low for both cows and bulls (Tables 2 and 3). It is difficult to estimate the relative proportion of concentrate and grass intake. The bulls in this case appeared to consume more concentrate diet than grass, which is reasonable to assume because the concentrate ration was offered *ad libitum*. This assumption was supported by the excessive body condition score (8 to 9, scale 1 to 9) of the bulls. Based on this clinical assessment, bulls were consuming excessive magnesium and energy. Forage on cow pastures had moderate crude protein levels, low energy values and high levels of acid-detergent fiber (ADF) and neutral detergent fiber (NDF). This suggests that cows were fed more appropriately than the bulls, which resulted in acceptable body condition scores (5 to 7, scale 1 to 9).

"Decade's" dominant behavior, coupled with excessive energy, moderate protein and high levels of magnesium in the diet, could have led to excessive consumption of concentrate ration. This would result in high intake of magnesium and phosphate, leading to urolithiasis.

Young bulls were fed an average of 8 lb (3.63 kg as-fed, 3.3 kg dry matter basis) of concentrate ration each day. This amount was based on the age of the bulls (12 to 15 months) with an estimated weight of 880 lb (400 kg), and assumed they consumed 22.0 lb per day (10.0 kg) of dry matter (2.5% BW) for a daily gain of 2.2 lb (1.0-1.2 kg). The concentrate contained 1.78 Mcal of NE/kg for maintenance and 1.17 Mcal of NE/kg for gain. Forages contained 1.6 Mcal of NE/kg for maintenance and 1.0 Mcal of NE/kg for gain. According to the Nutrient Requirements of Beef Cattle (NRC),[7] 7.92 Mcal/day of NE for maintenance is required for an 880 lb bull gaining 2.2 lb (1.0 kg)/day, and 4.56 Mcal/day of NE for gain is required. Considering these values, if the bulls consume 8 lb (3.63 kg) of concentrate (3.3 kg dry matter) and 2.82 lb (1.28 kg dry matter) from pasture, total maintenance requirement was met (3.3 kg concentrate x 1.78 Mcal NE for maintenance/kg = 5.87; and 1.29 kg pasture x 1.6 Mcal NE for maintenance/kg = 2.06; therefore 5.87 + 2.06 = 7.93 Mcal/d NE for maintenance). This is equivalent to 10.1 lb (4.59 kg) of dry matter. After this, the bull could still consume 11.9 lb (5.41 kg) of dry matter from pasture (22 lb [10 kg] required – 10.1 lb [4.59 kg] consumed for maintenance). This amount of forage is equivalent to 5.41 Mcal/d of NE for gain because 2.2 lb (1 kg) of pasture (dry matter basis) contained 1.0 Mcal NE for gain. According to NRC[7] and this calculation, young bulls were consuming enough energy for a daily gain of 2.4 to 2.6 lb (1.1 to 1.2 kg).

With the same diet, bulls were consuming 452 g CP (~ 302 g metabolizable protein [452 g CP x 0.67]) from the concentrate (3.3 kg concentrate x 13.7% CP) and 2400 g CP (~ 1608 g metabolizable protein [2400 g CP x 0.67]) from the ryegrass pasture (6.7 kg pasture x 35.9% CP). Total consumption was 1910 g metabolizable protein, which is three times the amount required for an 880 lb (400 kg) bull gaining 2.6 lb (1.2 kg) per day, which would require 640 g metabolizable protein; however, as soon as animals were moved to a Bahia grass pasture (12% CP), protein supply normalized to recommended levels.

Regarding minerals, the concentrate ration supplied 46 g Ca, 20 g P and 15.5 g Mg, and ryegrass pasture supplied 27 g Ca, 62 g P and 17.4 g Mg. In total, 73 g Ca (requirement 40 g), 77.5 g P (requirement 21 g) and 32.9 g Mg (requirement 10 to 15 g) was supplied in the diet each day. When grazing Bahia grass pastures,

the bulls consumed 52 g of Ca, 35 g of P and 33 g of Mg, a more desirable intake. The major problem was the lush ryegrass pasture, which was extremely high in crude protein and P. Because the concentrate feed was already in inventory, we recommended that free-choice hay be fed in order to reduce ryegrass consumption. Fortunately, ryegrass pasture was only available until the end of February, at which time animals were moved to a Bahia grass pasture, which contained mineral levels closer to recommended levels.

Conclusion

Urolithiasis and subsequent urinary bladder rupture resulted from excessive consumption of phosphorus and magnesium. Excessive body condition played a negative role in the medical and surgical management. Energy and minerals should be restricted to recommended levels; overall feeding management should be monitored on a regular basis.

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Abstract

Use of an enzyme-linked immunosorbent assay in bulk milk to estimate the prevalence of *Neospora canium* on dairy farms in Prince Edward Island, Canada

Wendela Wapenaar, Herman W. Barkema, Ryan M. O'Handley, Chris J.M. Bartels

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This study evaluated the use of bulk milk as a diagnostic tool for estimation of herd-level *Neospora caninum* exposure in Atlantic Canada; it was used to estimate the prevalence of dairy farms with a within-herd *N. caninum*-seroprevalence ≥15% in Prince Edward Island (PEI). The variation over time of *N. caninum* antibodies in bulk milk is also reported. Skimmed bulk milk and individual serum samples were analyzed for *N. caninum* antibodies by using an enzyme-linked immunosorbent assay (ELISA). Bulk milk samples were collected in May 2004 (n=235), May 2005 (n=189), and June 2005 (n=235). The prevalence of dairy farms with a within-herd seroprevalence ≥15% PEI was 6.4% in May 2004. In May and June 2005, respectively, 10.1% and 10.2% of farms had a ≥15% within-herd seroprevalence. In 11 farms that were considered positive based on bulk milk samples, blood samples were collected from all adult cows in September 2005, in conjunction with a 4th bulk milk sample on the same day. The correlation coefficient between serology and bulk milk ELISA was 0.87. The results of this study demonstrate the the prevalence of *N. caninum* in dairy farms can be estimated by using a bulk milk ELISA.