PEER REVIEWED

Case Report–Obstructive Urolithiasis in a Feedlot Steer

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Abstract

An outbreak of urolithiasis occurred in a small beef cattle feedlot feeding a total mixed ration containing cracked corn, corn gluten, gluten balancer, hay and diatomaceous earth. A 1100 lb (500 kg) steer was presented to the Iowa State University Veterinary Diagnostic Laboratory for euthanasia and necropsy. Clinical signs included frequent tenesmus, evidence of abdominal pain, regurgitation and labored breathing. Serum chemistry revealed elevated BUN (160 mg/dl), creatinine (28.9 mg/dl), creatine kinase (2253 IU/L), and an inverted calcium-to-phosphorus ratio of 0.8. At necropsy, complete obstruction of the urethra with calcium phosphate (apatite) calculi was present. Based on the clinical pathology and extensive tissue damage in this animal, the prognosis was poor if surgical treatment had been elected.

Analysis of the total mixed ration revealed a calcium-to-phosphorus ratio of 1:1. This case highlights the importance of a prompt diagnosis of urinary calculi in symptomatic animals, and evaluation of the ration for possible mineral imbalances.

Résumé

Une épidémie d'urolithiase a eu lieu dans un parc d'engraissement de bouvillons nourris avec une ration totale mélangée contenant du maïs roulé, du gluten de maïs, un stabilisateur à base de gluten, du foin et de la terre diatomée. Un bouvillon de 1100 lbs (500 kg) a été reçu par le laboratoire de diagnostic du collège vétérinaire de l'Université de l'Iowa pour euthanasie et nécropsie. Les signes cliniques incluaient du ténesme, une douleur abdominale évidente, la régurgitation et une respiratoire haletante. L'examen du sérum a révélé des concentrations élevées d'azote uréique (160 mg/dl), de créatinine (28.9 mg/dl) et de la créatine kinase (2253 IU/L) de même qu'un rapport calcium sur phosphore inversé à 0.8. À la nécropsie, la présence d'une obstruction complète de l'urètre avec des calculs de phosphate de calcium (apatite) fut notée. Sur la base de l'examen pathologique et de l'étendue des dommages aux tissus, le pronostic associé au choix de la chirurgie pour le traitement n'était pas très bon.

L'analyse de la ration totale mélangée a montré un rapport calcium : phosphore de 1 :1. Ce cas met en lumière l'importance d'un diagnostic rapide des calculs urinaires chez les animaux symptomatiques et de l'évaluation de la ration pour découvrir des déséquilibres possibles au niveau des minéraux.

Introduction

Urinary tract obstruction is a sporadic cause of illness and death in feedlot cattle fed a high concentrate ration. Urolithiasis should be regarded as a metabolic or nutritional disease with all animals in the herd at risk. Emergency surgical intervention or humane euthanasia may be necessary due to the extremely painful condition in affected animals. This case report describes the clinical and pathological findings that were observed in a steer with complete urethral obstruction. The report further highlights the importance of evaluating the ration to detect possible mineral imbalances.

History

Three of 80 steers on a small feedlot died in a 3-week period. No necropsies were performed. The producer reported the animals were fed a total mixed ration (38 lb/animal) comprised of corn gluten (760 lb/ton of feed), hay (160 lb/ton), cracked corn (960 lb/ton), diatomaceous earth (DE, 100 lb/ton) and gluten balancer (20 lb/ton). Cattle were offered a loose trace-mineral-salt mixture[a] *ad libitum*. The steers were also fed a corn gluten/diatomaceous earth (DE) mixture at 2 lb/head/day for about 4 months prior to the outbreak. Two pounds of the gluten/diatomaceous earth mixture replaced 3 lb of corn and contained 13.3% crude protein, 34.6% fat, 41.5% neutral detergent fiber (NDF), and had 1.42 Mcal/kg NEM.

Clinical and Pathological Findings

A live 1100 lb (500 kg) Angus steer was submitted to the Iowa State University Veterinary Diagnostic Laboratory for diagnosis of what was reported to be an acute onset of respiratory distress. At arrival the animal displayed marked signs of aggressiveness and exhibited severe dyspnea with neck extension, tongue protrusion and excessive salivation. At necropsy, the subcutaneous tissues of the ventral abdomen and rear legs were very edematous and had a uremic odor. The urinary bladder was severely distended with dark red urine. The mucosa of the bladder was markedly hemorrhagic and small, sand-like calculi were observed grossly. The urethra contained numerous calculi which completely obstructed the lumen immediately anterior to the pelvic flexture of the penis (Figure 1). Both kidneys were swollen and surrounded by severe retroperitoneal edema. The lungs did not collapse, were edematous, and had multifocal hemorrhages; the trachea was full of froth.

Histopathology

The transitional epithelium of the bladder had sloughed from the mucosa in many areas, and focal microulcerations were prominent throughout the mucosa (Figure 2). The bladder wall contained degenerate muscle bundles with neutrophilic infiltration. Markedly dilated distal tubules and Bowman's capsules were observed in kidney tissue (Figure 3). Marked interlobular and alveolar edema were present in the lungs, along with multifocal alveolar hemorrhages (Figure 4). Heart, brain, liver and intestines were unremarkable.

Bacteriology and Clinical Pathology

No bacterial pathogens were isolated from the urine, lungs or kidneys. Serum chemistry results are detailed in Table 1. Creatinine and BUN were elevated 16 and 6 times above the normal level, respectively. Urinalysis revealed numerous erythrocytes (Table 2). The recovered calculi were submitted for analysis by optical and x-ray crystallography.[b] The calculi consisted of 100% calcium phosphate (apatite).

Feed Analysis

The total mixed ration (TMR) was analyzed for calcium, phosphorus and magnesium. The level of magnesium in the ration was 0.18% (dry matter [DM] basis), which was adequate but not excessive when compared with recommended levels of 0.1%.[5] The concentration of calcium and phosphorus in the TMR was 0.4 and 0.39%, respectively, on a dry matter basis. This met the requirements for each element, but did provide

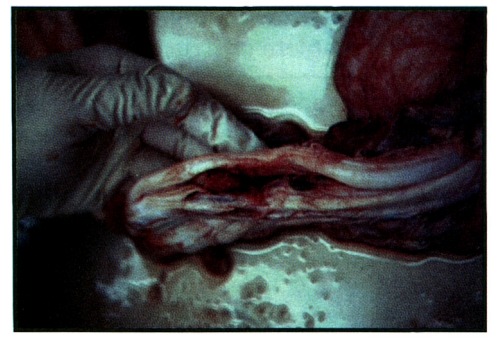

Figure 1. Apatite calculi obstructing the urethra.

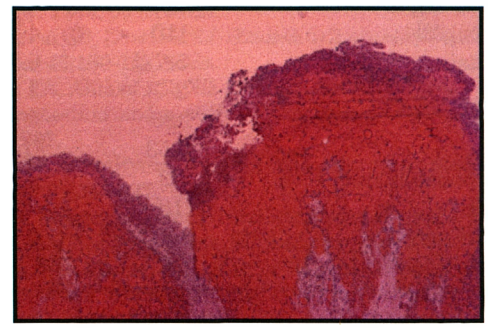

Figure 2. Section of the urinary bladder mucosa showing severe hemorrhage and loss of transitional epithelium in ulcerated areas.

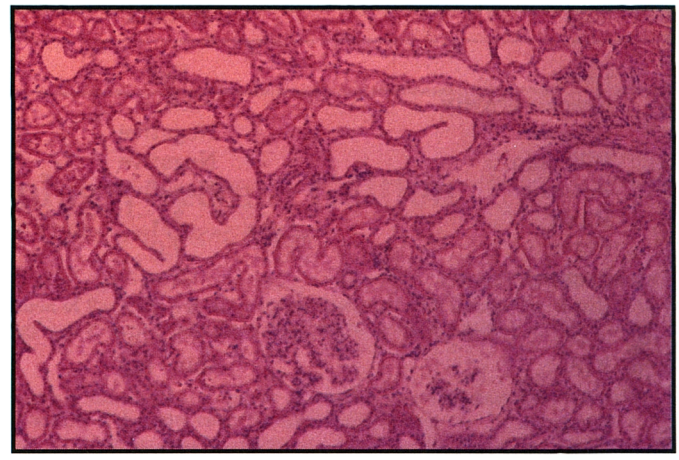

Figure 3. Section of the kidney showing dilated tubules and Bowman's capsule.

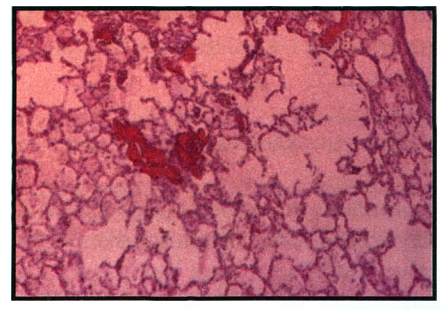

Figure 4. Section of lungs with a focal area of hemorrhage and alveolar wall disruption.

Table 1. Serum chemistry profile of a feedlot steer with complete obstructive urolithiasis.

Test	Result	Normal range
Sodium, mEq/L	140	132-152
Potassium, mEq/L	7.1	3.9-5.8
Chloride, mEq/L	94	100-115
TCO2, mEq/L	21.5	21-31
Calcium, mg/dl	8.0	8.0-11.4
Phosphorus, mg/dl	10.0	5.6-8.0
Magnesium, mg/dl	4.78	1.82-3.53
BUN, mg/dl	160	10-25
Creatinine, mg/dl	28.9	0.1-1.8
Glucose, mg/dl	110	40-100
Total protein, gm/dl	5.7	6.7-7.5
Albumin, gm/dl	2.7	2.5-3.8
AST, IU/L	226	55-125
CK, IU/L	2253	1-350
Alkaline phosphatase, IU/L	99	25-250
GGT, IU/L	16	1-50
T. bilirubin, mg/dl	0.31	0.1-1.6
Anion gap, mEq/L	28	12 – 22

Table 2. Urinalysis of a feedlot steer with obstructive urolithiasis.

Test	Results
Color	Red
Specific gravity	1.019
Glucose	Negative
Bilirubin	Negative
Ketones	Negative
Blood	3 +
PH	7.0
Protein	3 +
Cast	0 / lpf
WBC	1 – 3 / hpf
RBC	tntc / hpf
Crystals	0
Bacteria	0
Epithelial cells	0

a Ca:P ratio of at least 1.5:1, or ideally 2:1. The corn by-product contained 0.21% calcium, 0.23% phosphorus and 0.02% magnesium.[c]

Discussion

The formation of calcium phosphate urinary calculi was attributed to an imbalance of calcium and phosphorus in the TMR, and was not associated with the diatomaceous earth as initially suspected. The Ca:P ratio of the DE was 1:1, and DE accounted for only a small portion of the ration. Without analyzing each component of the ration, it is difficult to evaluate which ingredient may have contributed to the mineral imbalance. It is well known that corn gluten is a poor source of calcium, but is high in phosphorus, thus an appropriate amount of calcium-containing gluten balancer is required to achieve the proper calcium-phosphorus ratio. Gluten balancer tends to be costly. In this case, the amount of gluten balancer added to the ration did not provide the 0.6 lb/head/day recommended for cattle consuming feedlot rations containing 25-35% corn gluten.

The calcium phosphate calculi found in this steer are the most common type observed in feeder calves fed high concentrate rations (high in phosphorus and low in calcium), and tend to form in alkaline urine.[4] In experimental studies, steers fed diets containing equivalent concentrations of Ca and P (0.3 and 0.28%, respectively) had more urinary calculi at slaughter compared to steers fed higher concentrations of calcium ranging from 0.6 to 1.2% DM.[2]

Once the mineral imbalance was identified in this case, the ration was modified to contain 1% salt, and to provide 2 ounces/head/day of ammonium chloride. This treatment is designed to increase water consumption to dilute the urine, and to lower the urine pH to prevent formation of phosphate stones. Experimental studies have shown that salt included in the diet at 2% of DM prevented calculi formation in veal calves.[6] It should be noted, however, that adding salt to the ration will increase urine volume and may precipitate the rupture of the urethra or bladder in animals with a partial blockage.

In addition to the salt and ammonium chloride, ground limestone was initially added to the TMR to provide 2 ounces/head per day. Following a second feed analysis, the level was increased to 3 ounces/head/day. This raised the calcium level in the ration by another 0.2% (DM basis). A calcium-to-phosphorus ratio of 1.2:1 is recommended by the National Research Council,[5] but increasing the ratio to 2:1 reportedly has anti-calculogenic effects in cattle.[1]

In this case, magnesium levels in the diet were normal; however, high magnesium in the diet has been reported to cause calcium phosphate uroliths in calves,[3] and should therefore be considered when examining the ration for mineral imbalances.

The altered serum chemistries of the steer in this report suggested that there had been complete obstruction of the urinary tract for several days and that renal disease was advanced. An inverted calcium-to-phosphorus concentration in serum typically reflects severe renal failure, and together with the elevated magnesium, anion gap, creatine kinase and AST, indicates widespread tissue breakdown. An inverse ratio of calcium-to-phosphorus in serum not only occurs with kidney failure, but also reflects intracellular phosphorus

release and calcium influx into damaged cells. Based on the altered serum chemistries and pathologic findings, the prognosis was unfavorable and the condition was too advanced for surgical intervention. There was complete devitalization of the bladder wall and mucosa, damage to the distal kidney tubules and glomeruli, and extensive subcutaneous hemorrhage and edema. Respiratory distress had caused rupture of the alveolar septa, and multifocal hemorrhages in the lungs were observed microscopically.

In the two weeks following diagnosis of obstructive urolithiasis, a urethrostomy was successfully performed on three additional steers. Follow-up two months later did not reveal any further cases.

Conclusion

This report demonstrates the importance of early diagnosis of urolithiasis in feedlot steers. History, clinical signs, altered serum chemistry values and necropsy examination are useful to diagnose urolithiasis. Feed analysis, in particular calcium, phosphorus and magnesium, is important to determine the cause of calculi formation, and to develop therapeutic and nutritional plans to prevent further cases.

Footnotes

[a] ADE Mineral™, Kent Feeds, Inc, 1600 Oregon St., Muscatine, IA 52761

[b] Urolithiasis Laboratory Inc, 9525 Katy Fwy., Suite 222, Houston, TX 77024

[c] Forage Testing Laboratory, Dairy One, Inc, Ithaca, New York 14850

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