RESEARCH ARTICLE

Ultrasound-Guided Tube Cystostomy with Ammonium Chloride Orally for the Treatment of Obstructive Urolithiasis in Male Buffalo Calves

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Abstract

The present study was carried out to evaluate the efficacy of ultrasound-guided tube cystostomy along with ammonium chloride for the treatment of obstructive urolithiasis in male buffalo calves. Six clinical cases of obstructive urolithiasis having intact urinary bladder formed the materials of the study. The confirmed cases of obstructive urolithiasis (diagnosed based on history, clinical signs, ultrasonography, haemato-biochemical and urine analysis) were managed by ultrasound-guided tube cystostomy along with ammonium chloride administered orally @ 500 mg/kg body weight once a day for 25 days. At various postoperative intervals, variations in haemato-biochemical and urine parameters were noted, *i.e.,* soon after surgical procedure, after 24 h of surgery, and after complete recovery. The pre-operative altered haemato-biochemical and urine profile was found to be normalized post-operatively after complete recovery from the obstructive urolithiasis and the ammonium chloride resolved the struvite uroliths from the urine. The median time required for initiation of dribbling of urine through the urethra post-operatively was 10 (7-13) days, and the free flow of urine from the urethral orifice was found in 13 (10-17) days. From the present study, it may be concluded that ultrasound-guided tube cystostomy is a very effective method for the treatment of obstructive urolithiasis in male buffalo calves along with ammonium chloride as urine acidifier and solvent of struvite uroliths.

Key words: Ammonium chloride, Buffalo calves, Obstructive urolithiasis, Ultrasound-guided tube cystostomy.

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Introduction

Urethral obstruction is a hazardous condition that frequently contributes to the rupture of the bladder or extra-pelvic urethra in the bovines. A urethral obstruction occurs almost exclusively in male ruminants due to the anatomical conformation. The existence of a sigmoid flexure of the urethra in males makes them more susceptible to suffering from obstructive urolithiasis (Divers, 2022). The diet is the single most important element in urolithiasis. Struvite and calcium-based uroliths are the two types of uroliths that are encountered most frequently. The main contributing factor to most cases of struvite crystalluria in feeder animals is high-concentrate diets with mineral imbalances, particularly diets high in phosphorus and low in calcium (Armstrong, 2023), low roughage diets, limited intake of water, dehydration, urine alkalinity, excess of sodium bicarbonate in diet, vitamin imbalance, high protein rations etc are significant causes (Samal *et al.,* 2011). Ultrasound-guided tube cystostomy is recommended over conventional tube cystostomy for the management of obstructive urolithiasis in male buffalo calves having intact urinary bladder (Dangi *et al.,* 2022[a.b]). Oral administration of ammonium chloride can be used for acidification of urine. The present study was carried out to evaluate the efficacy of ammonium chloride and ultrasound-guided tube

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cystostomy for the treatment of obstructive urolithiasis in male buffalo calves.

Materials and Methods

Six male buffalo calves with intact urinary bladder and obstructive urolithiasis underwent the current clinical trial at the Veterinary Clinical Complex of the Lala Lajpat Rai University of Veterinary and Animal Sciences in Hisar (India). Blood/Serum samples and urine samples were collected at different intervals, *i.e.,* pre-operatively, after surgery, after 24 h of surgery, and after complete clinical recovery for assessment of haemato-biochemical profile and urinalysis. Preoperative transabdominal ultrasonography was done utilizing a 4 MHz convex transducer to assess the urinary bladder›s condition, wall thickness, and presence of urinary calculi, if any (Fig. 1). The calves were treated with ultrasound-guided tube cystostomy and per oral administration of ammonium chloride @ 500 mg/kg body weight once a day for 25 days.

The calf was restrained in right lateral recumbency and sedated with xylazine intravenously @ 0.01 mg/kg body weight. The surgical site (ventro-lateral abdomen) was then locally infiltrated with approximately 5 mL of 2% lignocaine HCl. After the animal was prepared for aseptic surgery, a 4 MHz sector probe was positioned at the intended surgical site to identify the location of the intact urinary bladder. Under the supervision of an ultrasonogram, a stab incision was made over the skin and fascia. Through the urinating port of Foley's catheter, the artificial insemination gun's plunger was introduced up to the eye of Foley's catheter and the catheter was then pushed into the bladder together with the plunger, and the catheter bulb was inflated (Fig. 2). A simple interrupted skin suture was applied at the surgical site using silk No. 1. The remaining catheter was attached to the abdomen wall in a loop. Using a pH meter, the pH of the urine samples collected was determined. Urine samples were centrifuged at 2075 x g for 5 min and sediments were analysed microscopically for the presence of struvite calculi.

The surgical site was dressed with 10% povidone-iodine solution. Broad spectrum antibiotics, *i.e.,* Ceftriaxone and tazobactam (Intacef tazo®, Intas Pharmaceuticals Ltd.) and Amikacin (Amicin®, Zydus Healthcare Limited) each @ 10 mg/kg body weight, and anti-inflammatory drug Meloxicam (Melonex®, Intas Pharmaceuticals Ltd.) @ 0.5 mg/kg body weight were administered I/M for 5 days. Ammonium chloride was administered orally @ 500 mg/kg body weight once daily for 25 days.

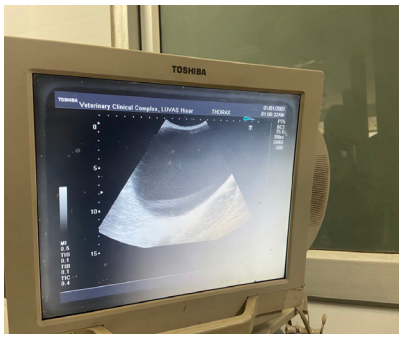

Fig. 1: Ultrasonographic picture showing intact urinary bladder

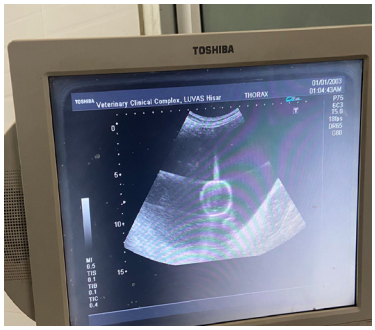

Fig. 2: Ultrasonographic picture showing inflated Foley's catheter balloon inside the urinary bladder

Results and Discussion

A round body with tensed bladder wall was visualized as an intact urinary bladder upon ultrasonographic examination. It revealed multiple small hyperechoic structures of varying sizes swirling in the anechoic fluid (urine). As revealed from the haematological data presented in Table 1, the preoperative values of Hb, PCV, TEC, TLC, and neutrophils were found to be elevated due to obstructive urolithiasis and all these decreased significantly ($p<0.05$) after recovery. This might be due to dehydration which results in haemoconcentration. Following the treatment of the urethral obstruction, the commencement of rehydration by fluid therapy and regular consumption of feed and water may have caused Hb and PCV values to decline towards normal level at various post-operative intervals (Mangotra *et al.,* 2017). At the same time, lymphocytes and monocytes were lower which increased significantly after recovery.

As revealed from the serum biochemistry (Table 2), the preoperative values of BUN, creatinine, potassium, phosphorus, AST, ALT, and globulin were much higher than normal and all these decreased significantly ($p<0.05$) at 24 h of surgery and highly significantly ($p<0.01$) decreased after complete recovery. Preoperatively, lowered values of chloride, calcium, and albumin were recorded in the current investigation. However, serum sodium and total protein values were towards the lower end of the normal range. Elevated levels of BUN and creatinine were due to increased retention time of urine in the urinary bladder which resulted in their reabsorption in blood. Additionally, the backflow of urine leads to hydronephrosis which hinders the glomerular filtration rate, elevating BUN and creatinine values (Mangotra *et al.,* 2017). Similar findings were recorded by Saini, (2020) and Dangi *et al.,* (2022[a]) . Hyperkalaemia could be attributed to the release of ions from the damaged cells due to possible tissue hypoxia in uremic cases. The postoperative decrease in potassium values towards the normal range could be attributed to correction of uraemia and dehydration, and clearance of potassium in

Table 1: Mean ± SE pre- and post-operative values of haematological parameters in buffalo calves suffering from obstructive urolithiasis

Parameters	Pre-operatively	After surgery	After 24 hrs	After recovery
Haemoglobin (g/dL)	13.24 ± 0.13^{A}	13.17 ± 0.12^{A}	12.87 ± 0.13^{A}	11.05 ± 0.05^{B}
PCV (%)	42.17 ± 0.37^{A}	42.08 ± 0.37^{A}	41.00 ± 0.36^{B}	35.73 ± 0.34^{C}
TEC ($\times10^{6}$/µL)	6.42 ± 0.01^{A}	6.38 ± 0.01^{A}	6.31 ± 0.02^{A}	5.86 ± 0.01^{B}
TLC ($\times10^{3}$/µL)	14.35 ± 0.02^{A}	14.32 ± 0.02^{A}	13.86 ± 0.02^{B}	10.51 ± 0.02^{C}
Neutrophils (%)	65.67 ± 0.42^{A}	65.00 ± 0.58^{A}	62.33 ± 0.56^{B}	39.00 ± 0.26^{C}
Lymphocytes (%)	31.83 ± 0.40^{C}	32.50 ± 0.50^{C}	34.83 ± 0.79^{B}	57.00 ± 0.26^{A}
Monocytes (%)	1.67 ± 0.21^{B}	1.67 ± 0.21^{B}	2.33 ± 0.21^{A}	2.67 ± 0.21^{A}
Eosinophils (%)	0.83 ± 0.17^{AB}	0.83 ± 0.17^{AB}	0.50 ± 0.22^{B}	1.33 ± 0.21^{A}

Means with different superscripts within the row vary significantly ($p<0.05$).

Table 2: Mean ± SE pre- and post- operative values of biochemical parameters in buffalo calves suffering from obstructive urolithiasis

Parameters	Pre-operatively	After surgery	After 24 h	After recovery
BUN (mg/dL)	69.25 ± 1.33^{A}	69.19 ± 1.32^{A}	58.04 ± 1.62^{B}	21.55 ± 1.38^{C}
Creatinine (mg/dL)	5.37 ± 0.03^{A}	5.37 ± 0.03^{A}	3.37 ± 0.04^{B}	1.34 ± 0.03^{C}
Sodium (mmol/L)	134.28 ± 0.51^{B}	134.30 ± 0.51^{B}	135.15 ± 0.52^{B}	136.67 ± 0.45^{A}
Potassium (mmol/L)	6.31 ± 0.02^{A}	6.31 ± 0.02^{A}	5.67 ± 0.01^{B}	4.35 ± 0.01^{C}
Chloride (mmol/L)	89.82 ± 0.43^{B}	89.83 ± 0.43^{B}	90.89 ± 0.49^{B}	99.72 ± 1.01^{A}
Calcium (mg/dL)	7.43 ± 0.05^{C}	7.43 ± 0.04^{C}	7.73 ± 0.03^{B}	11.25 ± 0.06^{A}
Phosphorus (mg/dL)	11.34 ± 0.07^{A}	11.32 ± 0.07^{A}	10.53 ± 0.08^{B}	5.75 ± 0.04^{C}
Total Proteins (g/dL)	6.63 ± 0.06^{A}	6.63 ± 0.06^{A}	6.54 ± 0.06^{A}	6.32 ± 0.04^{B}
Albumin (g/dL)	2.87 ± 0.05^{A}	2.87 ± 0.05^{A}	2.81 ± 0.05^{A}	2.73 ± 0.03^{B}
Globulin (g/dL)	3.76 ± 0.07^{A}	3.76 ± 0.07^{A}	3.73 ± 0.06^{A}	3.59 ± 0.07^{B}
ALT (IU/L)	141.83 ± 0.44^{A}	141.82 ± 0.45^{A}	140.86 ± 0.53^{A}	117.47 ± 0.60^{B}
AST (IU/L)	48.83 ± 0.38^{A}	48.83 ± 0.38^{A}	47.66 ± 0.40^{A}	41.28 ± 0.64^{B}

Mean with different superscripts within the row vary significantly ($P<0.05$).

the urine (Saurabh *et al*., 2016). Higher pre-operative values of AST and ALT could be a result of uraemia and dehydration-related cellular damage in several organs, *i.e.,* non-specific tissue damage in different organs (Mangotra *et al.,* 2017). The study suggests that hyperphosphatemia and hypocalcaemia could be linked to the consumption of concentrate diets that are high in phosphorus and low in calcium. The absorption of calcium is influenced by the ratio of calcium to phosphorus in the gastrointestinal tract, and an increase in phosphorus levels can decrease the absorption of calcium. Therefore, the elevated phosphorus levels in the concentrate diets might have additionally hindered the absorption of calcium from the gastrointestinal tract. Similar results were reported by Dangi *et al*. (2023). Hypochloraemia is attributed to nutritional chloride deficiency due to anorexia and chloride being sequestered into the digestive tract to make up for a significant increase in potassium ions (Saurabh *et al*., 2016). Relatively lower preoperative value of total protein could be attributed to anorexia and malnutrition (Dangi *et al*. ,2023). The passage of albumin into the extracellular compartment as a result of injury to the urinary bladder may have caused the pre-operative value of albumin to be lower than the normal reference range, whereas globulin level was higher than the normal range throughout the entire study period (Mangotra *et al.,* 2017).

The colour of urine samples of the affected animals ranged from dark yellow to brown, which might be attributed to concentrated urine due to the presence of sabulous material in the urinary bladder. Following surgery, the anomalous urine colour began to change to a light yellow or straw colour, likely as a result of the cessation of urinary tract bleeding and the removal of sabulous material from the urine (Saurabh *et al*., 2016). Preoperatively, urine pH was alkaline (8.12±0.05, Table 3), which could be due to urethral infection or the conversion of urea into ammonia (Mangotra *et al.,* 2017). Ruminants are prone to developing struvite calculi due to their dietary habits of consuming both forages and concentrate, and the alkaline nature of urine. Postoperatively, oral administration of urinary acidifier (ammonium chloride) led to a reduction in the pH of urine. Similar findings were recorded by Dangi *et al*. (2022[b]). Prior to surgery, the specific gravity of urine was 1.009±0.002, which was lower than the reference range (1.025-1.045) (Table 3). Both urine pH and specific gravity got normalized after complete recovery from urolithiasis.

Table 3: Mean± SE value of urine pH and specific gravity of animals at different intervals

Parameter	Pre-operatively	After surgery	After 24 h	After recovery
Urine pH	8.12 ± 0.05^{A}	8.08 ± 0.05^{A}	7.90 ± 0.04^{B}	7.35 ± 0.04^{C}
Sp. gravity	1.009 ± 0.002^{C}	1.009 ± 0.002^{C}	1.016 ± 0.002^{B}	1.027 ± 0.001^{A}

Mean with different superscripts within the row vary significantly (P<0.05).

Pre-operatively, struvite crystalluria was recorded microscopically in the present study, which was due to alkaline urine and a phosphate-rich diet. Similar findings were observed by Dangi *et al*. (2022[b]). Following surgery, oral administration of ammonium chloride resulted in the acidification of urine and subsequent dissolution of struvite uroliths which concurred with the findings of Anton *et al*. (2014). Preoperative glycosuria seen in the present study could be due to decreased tubular reabsorption or a lowered renal glucose threshold, which was resolved post-operatively due to the restoration of urinary system functioning. Proteinuria noted in the current investigation could be caused by acute nephritis or inflammatory exudation from pyelitis, urethritis, cystitis, and urolithiasis. The current findings are supported by Saini (2020) and Dangi *et al*. (2022[b]).

The post-operative average time of initiation of dribbling of urine through the urethra was 10 (7-13) days. However, the free flow of urine from the urethral orifice was seen after 13 (10-17) days. In the present study, the average time needed to complete the USG guided tube cystostomy was quite lower (5-8 min, Av. 6.5 min) as compared to a conventional tube cystostomy, *i.e.,* 23 min and 30 min reported by Dangi *et al.* (2022[a]) and Kumar *et al.* (2022), respectively. For the placement of the Foley's catheter, the conventional tube cystostomy requires a 3-4 cm long incision, while USG-guided technique requires a stab incision only (Dangi *et al.,* 2022[a]), and also USG guided tube cystostomy produces less stress and less inflammation than conventional tube cystostomy (Dangi *et al.,* 2023). Therefore, this method is better than conventional tube cystostomy in bovine calves with an intact urine bladder. The findings of the current investigation are supported by those of the earlier studies (Dangi *et al.,* 2022[a]; Kumar *et al.,* 2022).

Conclusions

The ultrasound-guided tube cystostomy is a quick, straightforward, and less time-consuming procedure. Hence it can be suggested as the first line of treatment for obstructive urolithiasis in buffalo calves with an intact urinary bladder. Oral administration of ammonium chloride as acidifier acts as a good sovent of struvite uroliths.

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