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Surgical Management of Obstructive Urolithiasis in Small Ruminants by Tube Cystostomy in Chittagong, Bangladesh

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Abstract: The present study was conducted to evaluate minimally invasive tube cystostomy technique in goats and calves suffering from obstructive urolithiasis having intact and ruptured urinary bladder. This clinical study was carried out on 84 clinical cases (61 goats and 23 calves) based on the history, clinical signs and physical examination along with common laboratory techniques at the Chittagong Veterinary and Animal Sciences University during January 2015-December 2016. Physical parameters like heart rate, respiratory rate, rectal temperature and dehydration status of animals were noted and corrected abnormality before surgery. Some cases had slightly higher haemoglobin (Hb), packed cell volume (PCV) and uric acid and epithelial casts in urine. The study revealed that abnormal calcium-phosphorus ratio was predisposing the animals to urolithiasis. It was found that young ruminants (3-5 months) were most commonly affected in both species. All affected animals were male in this study, in which calves were not castrated but in goats 95.08% animals were castrated. Rupture of bladder was more common in calves as compared to goats. Postoperatively all cases were administered with broad-spectrum antibiotic, anti-inflammatory agent and caliculolytic agents like ammonium chloride. Tube cystostomy with Foley's catheter was the most satisfactory technique for the management of obstructive urolithiasis in small ruminants. Postoperative complications were recorded only in four animals and remaining 80 animals had a normal recovery from tube cystostomy. Tube cystostomy is a simple, inexpensive and very effective procedure for the treatment of urolithiasis in ruminants.

Key words: Small ruminants, Foley's catheter, tube cystostomy, urolithiasis.

1. Introduction

Urolithiasis is a condition of the urinary tract in which insoluble mineral and salt concretions develop and aggregate around a nidus of proteineous material within the bladder or urethra [1]. Urolithiasis refers to the disease conditions resulting in urethral obstruction [2]. It is the most widespread and economically important disease of ruminants, which affects both sexes; however, urinary blockade is a major problem only in males. Steers are most commonly affected by the obstructive form of the disease because of the anatomical confirmation of their urinary tract [3]. It is the second biggest cause of death behind respiratory disease [4, 5]. Urolithiasis is commonly reported in young, castrated male pet goats that associated with some factors including gender, age of castration, diet, urine pH and concentration [6]. Urethral obstruction has been extensively reported in ruminant species [7] and is a common problem encountered in male sheep, goat and cattle [8]. Among the bovine species, buffalo calves, 81.25% suffered more frequently than the cow calves 9.82% and bullocks 8.92% [9]. The calculi is mostly found in urinary bladder, but can also occur in renal pelvis and urethra [10]. The calculi dislodged from bladder may get trapped in narrow male urethra, sigmoid flexure [11] or at preputial opening. Urinary obstruction may also occur due to cystitis. An overall incidence of 20.8% in cattle and 44.4% in goat has been reported in Bangladesh [12].

The etiology is complex and multifactorial. It may occur due to excessive or imbalanced intake of

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minerals [13] in feedlots while fattening cattle receive rations high in cereal grain and oil meals. These feedstuffs have high levels of phosphorous and magnesium but relatively low level of calcium and potassium predispose to disease condition [14]. A calcium phosphorous imbalance results in high urinary phosphate excretion, which is an important factor in the genesis of phosphate calculi [15]. Numerous additional factors have been incriminated as contributing causes of the development of phosphate calculi with resultant obstructive urolithiasis in cattle. These include heavy concentrate-low roughage diets, limited intake or deprived of water, dehydration, urine alkalinity, mineralized artesian water, alkaline water supplies, excess of sodium bicarbonate in diet, vitamin imbalance e.g. hypovitaminosis and hypervitaminosis and high protein rations [14, 16]. Less frequently uroliths composed of silica, carbonates or oxalate. Livestock grazing in pastures containing large quantities of oxalates, estrogen or silica is prone to developing these types of calculi [17]. Urolithiasis in castrated beef cattle has been reported to be associated with diethylstilbestrol implants [18]. Geographical and seasonal influences play an important role for range herds in semi-arid areas. In addition, the anatomy of the male ruminant urinary tract also contributes due to the potential narrowness of the passage and tortuous route [19]. The sigmoid flexure is a common site for uroliths to lodge in all ruminant species [18]. Uroliths may also be found on lesser occasion at the ischial arch. In small ruminants, the urethral process is an extremely common site for uroliths to lodge [20]. Nidus formation occurs when mucoproteins in the urine coalesce and precipitate with crystals in supersaturated urine [1]. If calculi increase in number or size, obstruction of tract may be found anywhere from urethral process to bladder in sheep and bucks [21] and in the sigmoid flexure in calves, which can rapidly progress to bladder or urethral rupture, uremic crisis and death may occur [20]. Clinical manifestation of urolithiasis in rams and bucks is remarkably different than in bovine species. They may show partial or complete obstruction, and complete obstruction with ruptured urinary bladder and hence demand different surgical under diverse clinical situations. In sheep and goats ultrasonographic scanning may be useful for the diagnosis and prognosis of this disease [3].

Obstructive urolithiasis in ruminants has been corrected with medicinal treatment but the result is unrewarding one. Treatment of obstructive urolithiasis is definitely surgical, once the obstruction is complete. Removal of calculi may be by direct or indirect bypassing the obstruction [22]. Tube cystostomy is the most commonly used treatment for long term management of obstructive urolithiasis in animals and may be the best option for breeding animals. It redirects the urine through a catheter placed from urinary bladder and exiting through the abdominal wall. The success rate of this technique has been reported to be 80% after one month of postoperative period [23]. The advantages of this technique are that it is a simple procedure, highly field applicable, a relatively short duration of anaesthesia and attains a full urethral patency in short period of time. At the best of our knowledge, this is the first clinical report on tube cystostomy for the treatment of urolithiasis in Bangladesh.

This study was undertaken to evaluate and standardize tube cystostomy for the management of obstructive urolithiasis in small ruminants to modify it for ready use at the field condition.

2. Materials and Methods

The study was conducted on clinical cases presented for surgical treatment of urolithiasis at Sahidul Alam Quaderi (SAQ) Teaching Veterinary Hospital, Chittagong Veterinary and Animal Sciences University, Chittagong, Bangladesh for two years. Total 84 male animals in which 61 goats aged between 2-12 months and 23 calves aged between 3-11 months developing urolithiasis formed the

materials for this study. Anamnesis and clinical history was made based on information about the previous treatment, nutritional history, type of feed, and symptoms. Physical examination was done to check the status of the urethra and urinary bladder and physiological parameters like heart rate, respiratory rate, rectal temperature, color of mucus membrane and dehydration for confirmation of the tentative diagnosis.

2.1 Haemato-Biochemical Study

For haemato-biochemical studies, required amount of blood was collected from patients by jugular venipuncture and then transferred into vacutainer containing ethylenediaminetetraacetic acid (EDTA) anticoagulant and without anticoagulant. The haemoglobin (Hb), packed cell volume (PCV), total erythrocyte count (TEC), total leukocyte count (TLC), differential leukocyte count (DLC) were estimated within 2-6 h of collection by using standard techniques [24]. Serum calcium, phosphorus, alkaline phosphatase and total protein were estimated by using the commercially available kits and the reading was taken by using spectrophotometer.

2.2 Urine Examination

For urine analysis, urine sample was collected by cystocentesis or during intra-operative period from intact urinary bladder and uroperitoneal fluid from ruptured urinary bladder. Then the urine samples were transferred to the laboratory for physical evaluation like color, pH and specific gravity and for microscopic examination to detect any abnormal deposition.

2.3 Observation of Urinary Bladder

The intra-operatively bladders were examined whether it was intact or ruptured and appearance of bladders like smooth, rough, inflamed and necroses had also been observed.

2.4 Operative Procedure

Surgical treatments are the only solution to save the animals. The choice of the appropriate surgical technique depends on the value and future use of the animal, location of the obstruction, and the respective integrity of the urethra and bladder. There are many surgical options for urolithiasis like surgical excision of urethral process, cystic catheterization and flushing, modified bladder marsupialization, urethrotomy, urethrostomy, cystotomy and tube cystostomy but in many cases, it provides temporary solution and further obstruction is very common. In this study, all 84 patients were subjected through the tube cystostomy operation.

Animals were stabilized preoperatively with fluid therapy and supportive therapy to those animals, which had severe dehydration and uremia. Stabilized animals were prepared for tube cystostomy and operated on the same day.

All the animals were sedated with diazepam at 0.4 mg/kg and anaesthetized with local anesthetic (2% lignocaine) for line infiltration at surgical site. Animals were placed in right lateral recumbency. Left side of the abdomen near the rudimentary teat area was shaved and scrubbed with antiseptic solution (Fig. 1a). After scrubbing, an incision was made nearly anterior to the rudimentary teat; bladder was located after separating subcutaneous tissue and muscles by blunt incision. Foley's catheter was passed from outside to abdominal cavity and directly secured to the bladder and its bulb was inflated with sterile normal saline for fixation (Fig. 1b). The Foley's catheter was then sutured at multiple sites (Fig. 1c) on the ventral abdomen to keep it in position (Fig. 1d).

Sometimes uroperitoneal fluid (Fig. 2a) was common in different cases. The status of the bladder was checked whether intact or ruptured and appearance of the bladder was also noted. Sometimes black colored urine (Fig. 2b) was common in necrosed urinary bladder. Urinary calculi (Fig. 2c) were commonly found in urine during surgery. For the intact bladder, subcutaneous tunnel was made parallel to the prepuce by passing straight mosquito forceps through the subcutaneous tissue at the end skin was

incised intended for catheter outlet. Conversely if bladder was ruptured (Fig. 3a) cystography followed by catheter placement was done after necessary debridement and irrigated with normal saline to remove concretions and cystic calculi. Ruptured urinary bladders (Fig. 3b) were common with the cases that had the history of complete urinary blockage for more than three days. Muscles and subcutaneous tissue were sutured with No. 1 catgut in continuous suture pattern. Skin was sutured with horizontal mattress with nylon No. 1.

Postoperatively owners were advised to give antibiotic streptopenicillin I/M for 6 d, analgesic, meloxicam at 5 mg/kg for 3 d and ammonium chloride at 200 mg/kg body weight, two times per day (b.i.d), orally for a period of one week. Application of local antiseptic and dressing with povidone iodine were advised for a week. The catheter was allowed to drain freely for 4 d (or until normal urination resumed) after which it was clamped on every alternate day with infusion set flow regulating clamp to determine the urethral patency.

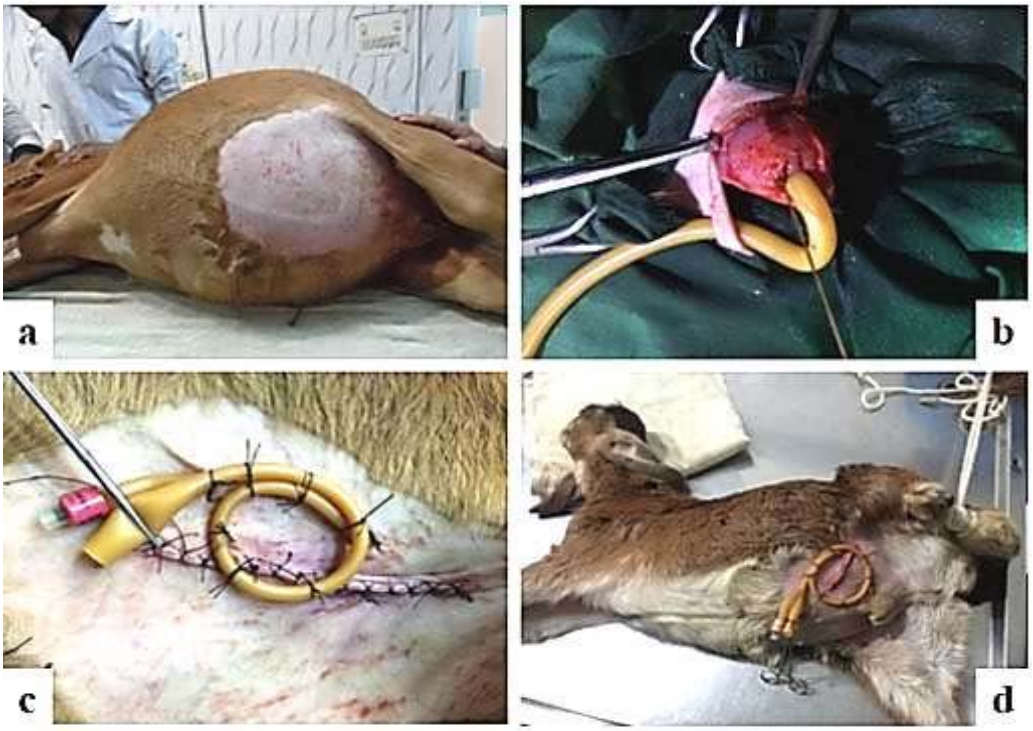

Fig. 1 Surgical steps for tube cystostomy.
(a) Urolithiasis in calf with distended abdomen; (b) tube cystostomy by using Foley's catheter; (c) fixation of Foley's catheter after tube cystostomy in calf; (d) fixation of Foley's catheter after tube cystostomy in goat.

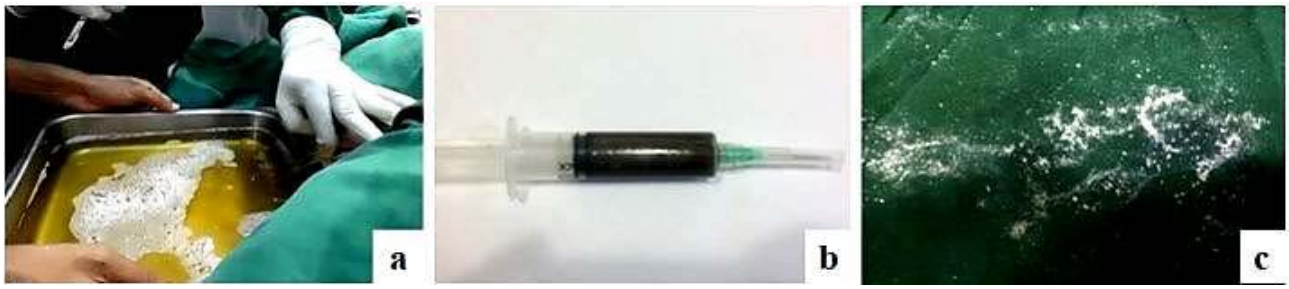

Fig. 2 Some findings during surgery.
(a) Collection of uroperitoneal fluid from the abdominal cavity during surgery; (b) collection of black colored urine from the necrosed urinary bladder; (c) collection of urinary calculi on drapers during surgery.

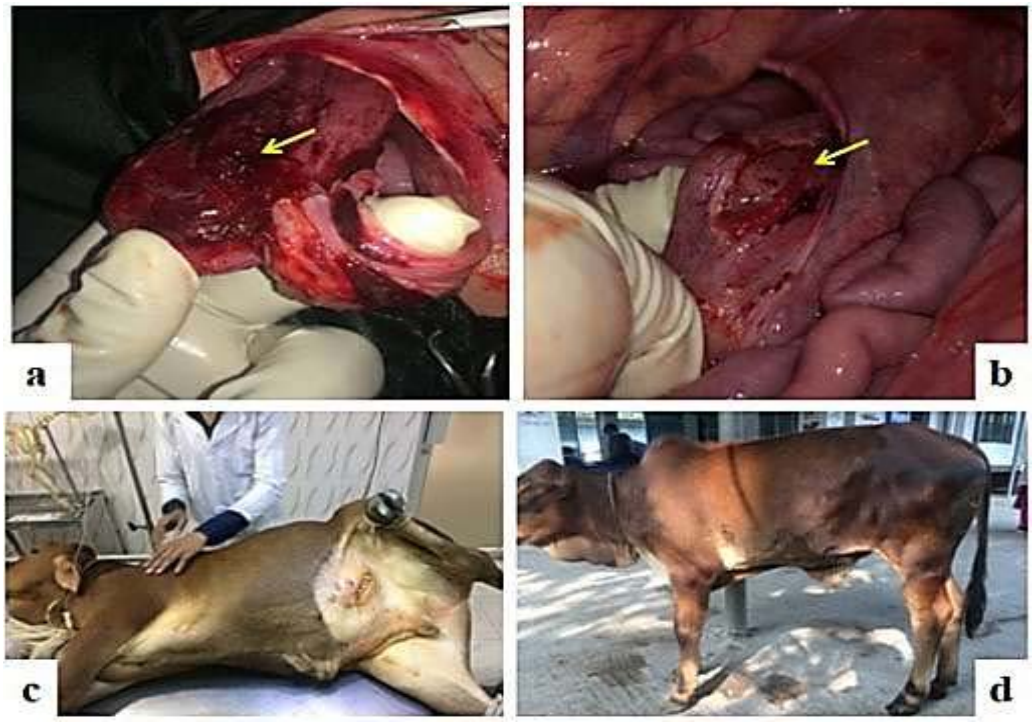

Fig. 3 During and after surgery of a patient: (a) rupture and severely serosal damage of urinary bladder (arrow) in calf; (b) ruptured urinary bladder (arrow); (c) patient after removal of Foley's catheter; (d) patient after normal urination.

All the animals were presented again to the authors' hospital for removal of catheter (Fig. 3c) whether normal urination was resumed through the urethra (Fig. 3d).

3. Results

All the goats and calves suffering from obstructive urolithiasis included in this study were males. They presented in the clinics with the complaint of complete absence of urination ranging from 1 d to 7 d. The occurrence of urolithiasis most commonly encountered in winter season. All bovine claves were not castrated but in goats 58 (95.08%) animals were castrated and three (4.92%) were not castrated. The age of calves mostly affected was from three months to five months. In goats 5-7 (64.71%) animals were in maximum ratio of incidence. In both species, young animals were mostly affected (Table 1).

In haemato-biochemical examination, blood pictures exhibited non-significant variations but few cases showed slight elevation of Hb and PCV and other parameters like TEC, TLC, monocytes, eosinophils and basophils were within the normal ranges. Among various biochemical parameters studied, the mineral profile showed that there was imbalance of calcium, phosphorus ratio. Other biochemical parameters such as alkaline phosphatase, total protein and magnesium levels were more or less within the normal ranges.

In physical evaluation of urine, abnormal dark and reddish color found in 26 and 19 patients, respectively, and 39 patients showed normal to pale yellow color urine. The urinary pH of clinically affected animals ranged between 7.9 and 9.3 with increased specific gravity ranged between 1.032 and 1.041. In many of the clinically confirmed cases epithelial casts and uric acid casts were observed during microscopic examination (Table 2).

Clinical signs of most of the animals with intact bladder were complete anorexia or inappetance, stranguria or anuria, reluctant to walk and frequent attempt to urination. Deep palpation on both sides of abdomen found 15 calves out of 23 were intact urinary bladder, remaining eight cases were suspected for

Table 1 Distribution and occurrence of urolithiasis in ruminants.

Species	Occurrence	Age in months	Incidence	Intact bladder	Ruptured bladder	Castrated	Uncastrated
Goats	61 (72.62%)	2-4 (13)	21.31%	50 (81.97%)	11 (18.03%)	58 (95.08%)	3 (4.92%)
		5-7 (41)	67.21%		Serosal rupture (7)		
		8-10 (5)	8.20%		Moderately necrosed (2)		
		11-12 (2)	3.28%		Severely necrosed (2)		
Bovine calves	23 (27.38%)	3-5 (15)	65.21%	15 (65.22%)	8 (34.78%)	Nil	23 (100%)
		6-8 (6)	26.09%		Serosal rupture (5)		
		9-11 (2)	8.70%		Moderately necrosed (2)		
					Severely necrosed (1)		

Table 2 Urinary examination findings.

Examined parameters	Major findings
Urine color	Normal to pale yellow (39) Dark (26) Reddish (19)
pH	7.9-9.3
Specific gravity	1.032-1.041
Microscopic examination	Epithelial casts Uric acid casts

ruptured bladder. In goat most of the animals had intact bladder 50 out of 61 with remaining the 11 out of 61 animals were suspected for ruptured bladder. In case of ruptured urinary bladder, bilateral ventral distension of abdomen might be noted and confirmed with abdominocentesis in which urine was present in abdomen. Dehydration status of animals was measured by skin tenting test, which showed that cases of ruptured bladder had shrunken eyeballs (sinking eye balls in the socket), severely dull and depressed and rough hair coat. Mild to moderate dehydration was noticed in those animals which had intact bladder. The level of dehydration in animals ranged from 4% to 10% (> 2-10 s) in which most of the bovine calves were within 4%-6%.

Tube cystostomy was the notable technique among the various available conventional surgical techniques for the treatment of urolithiasis. All the cases attained adequate analgesia at surgical site, which had no complication encountered. Catheterization of urinary bladder and positioning of tube was achieved without any difficulties. After tube placement, flow of urine through the tube was observed in all cases. Those animals presented within 2 d of urinary obstruction cases were having healthy urinary bladder, appeared smooth and pink in color intra operatively.

Those cases which presented after 3 d showed tensed bladder filled with urine, which appeared rough slightly and color varied from pinkish to blue. In ruptured bladder cases out of eight calves, five had serosal rupture; one was severely necrosed, remaining two moderately necrosed. In goats out of 11, two were necrosed and seven had serosal rupture (Table 1). Ruptured bladder cases mostly presented after 4 d to the hospital and the color of bladder was more dark bluish in color.

Post operatively the signs of acute pain and distress reduced immediately after surgery and animals started to feed normally after 6 h. Different postoperative complications were recorded in both the species which included urethral rupture in one and two blocks in calves and three tube blocks were encountered in goats.

In both species 98.04% animals got uneventful recovery without any complications and resumed normal urination through the urethra on 12-18 d of postoperatively onwards. Tube was removed after resuming normal urination through the urethral

orifice.

4. Discussion

Urolithiasis is a life threatening disease of ruminants that causes economic loss to the farmers due to loss of animals and cost of treatment. In cases of obstructive urolithiasis, mortality rate was very high resulted from ruptured urethra or urinary bladder [25]. In the present study, affected animals ages were within the range of 4-5 months in both bovine calves and goats; this finding was in consistent with other studies [26]. Similar results were observed by other authors on urethral obstruction of bovine calves [27, 28]. Castrated male goats had higher urethral obstruction compared to intact males. This variation in occurrence of early castration results in reduced testosterone which may cause hypoplasia of urethral orifice [1]. The reduction of testosterone may also decrease the protective hydrophilic colloid in the urine which increased the incidence of urolithiasis [6]. However, this variation was only noticed in goats not in bovine calves in this study. Desquamated epithelial cells may be due to deficiency of vitamin A and infections [29]. Occurrence of urolithiasis was more both in winter and summer in present study which was supported by the findings of Khurma *et al.* [26] and Radostitis *et al.* [30]. This may be related to water balance of animals, during winter animals will not take much water and produce concentrated urine [30]. Conversely, during the summer, urine may be more anti-concentrated due to increased water loss in the heat.

The prevalence of urolithiasis may occur due to imbalance of mineral intake in feed. In this study, the affected ruminants had also a history of more cereals and concentrate feedings. Lots of animals while fattening/growing received more cereals and concentrated feeds. These feeds contain more level of phosphorus and magnesium and relatively less level of calcium and potassium predisposed to this condition [15].

The results of haemato-biochemical and microscopic examination of urine in obstructive urolithiasis patients were similar with other studies [5], reported slightly higher Hb, PCV, TEC, red blood cell (RBC), white blood cell (WBC) and epithelial casts in urine and abnormal calcium-phosphorus ratio for urolithiasis.

The dehydration was usually marked in this study similar to others [30, 31]. It was due to water and electrolyte losses occurring over a period of several days resulting in loss of skin elasticity, dryness of the skin and mucosa, and a reduction and retraction of the eyeball (enophthalmia) due to reduction in the volume of the postorbital fat deposits [30]. Dehydration was more in cases of ruptured urinary bladder, which might be due to the loss of fluid from the interstitial and intracellular spaces into peritoneal cavity [31].

Diagnosis of urethral obstruction cases can be much easier; however selecting treatment modalities is much more difficult. Treatments include medicinal dissolution of calculi and surgical management. In general less severe cases can be corrected with medicinal management. Some report says that medicinal treatment is not effective for long term and only six provided temporary relief [32]. In more severely obstructed cases surgery is the only option.

In this study, tube cystostomy was the most promising procedure for the treatment of obstructive urolithiasis in small ruminants, and was performed by relatively simple way, with short duration of anaesthesia resulting restoration of full urethral patency. These similar findings were also described in the study of Ewoldt *et al.* [22] and Fortier *et al.* [33]. The free flow of urine through the external urethral orifice could be due to many factors. Anti-inflammatory drugs relived the spasm and inflammation of urethra, caliculolytic agent like ammonium chloride and sodium chloride along with water reduces pH of urine and it promotes the dissolution of calculi. Bypassing of urine through the Foley's catheter may reduce the calculi size and

frequent occlusion of catheter with clamp could bring urethral patency by flushing urethra of all debris and calculus material [32]. A retrospective study of short and long term outcome of surgical tube cystostomy in ruminants reported obstruction of catheter was minimal compared to other surgical methods [32].

Complication of tube cystostomy might be due to blockade of tube with blood or tissue debris, urethral rupture, tube dislodgement and infection [34]. Different surgical treatments are available for obstructive urolithiasis but each operation has their own advantages and disadvantages. Tube cystostomy surgery provides alternatives to those operations. Perineal urethrotomy (PU) and urethrostomy had been used to relive the obstruction on post scrotal or post ischial depending upon calculi lodegment. However, post-operative complications associated with stricture formation, resulting in recurrent urinary obstruction [35]. Bladder marsupialization is another surgical option but the quality and duration of postoperative life may be limited by such problems as urine scald, urinary tract infection, stricture, and prolapse of bladder mucosa [36]. In ruptured urinary bladder most of the animals were treated with frusemide HCl by local veterinarians before being presented to the hospital. Frusemide is a loop diuretic which increases the urine production by its loop diuretic action. Diuretics are recommended only for partial obstruction not for complete obstruction [30]. In complete obstruction, the production of urine was more because of diuretic action and it might have led to cause rupture of the bladder. This could be one of the major factors for rupture of bladder in ruminants in our cases. When the urinary bladder is ruptured, this gives relief for 1 d or 2 d. Thereafter animal may develop severe uremia and uroperitonium, which progresses into severe depression, anorexia and severe dehydration. Cystorrhaphy followed by tube cystostomy was done for those ruptured cases. The post-operative complications were recorded in few cases of our study, which includes urethral rupture and tube blockage. This may be due to medicinal mismanagement like lack of tube flushing frequently; dislodgement of tube may be deflation of bulb of the catheter or dietary mismanagement.

5. Conclusions

Tube cystostomy was found most appropriate and novel technique for the treatment of life threatening problem urolithiasis in ruminants. It is a quick, practicable, field applicable, and reliable method for the management of obstructive urolithiasis in ruminants. Additionally, it is cost effective and satisfactory procedure that minimizes exposure of abdominal cavity of metabolically compromised animals with minimum instruments. From this study, it was concluded that this procedure is recommended for the field condition to save life from obstructive urolithiasis in ruminants.

References

[1] Belknap, E. B., and Pugh, D. G. 2002. *Diseases of the Urinary System: In Sheep and Goat Medicine*, edited by Pugh, D. G., and W. B. St. Louis, MO: W. B. Saunders Company, 255-76.

[2] Onmaz, A. C., Albasan, H., Lulich, J. P., Osborne, C. A., Gunes, V., and Sancak, A. A. 2012. “Mineral Composition of Uroliths in Cattle in the Region of Kayseri.” *Journal of Faculty of Veterinary Medicine Erciyes University* 9: 175-81.

[3] Makhdoomi, D., and Gazi, M. A. 2013. “Obstructive Urolithiasis in Ruminants—A Review.” *Veterinary World* 6 (4): 233-8.

[4] Ismail, Z. B., Al-Zghoul, M., Al-Majali, A., and Khraim, N. 2007. “Effects of Castrationon Penile and Urethral Development in Awassi Lambs.” *Bulgarian Journal of Veterinary Medicine* 10 (1): 29-34.

[5] Vinodh Kumar, O. R., Swarnkar, C., Shinde, A., and Singh, D. 2010. “Clinical, Mineral and Haemato Biochemical Studies of Urolithiasis in Weaner Lambs.” *African Journal of Agricultural Research* 5 (15): 2045-50.

[6] Tamilmahan, P., Mohsina, A., Karthik, K., Gopi, M., Gugjoo, M. B., and Zama, M. M. S. 2014. “Tube Cystostomy for Management of Obstructive Urolithiasis in Ruminants.” *Veterinary World* 7 (4): 234-9.

[7] Braun, U., Trosch, L., and Sydler, T. 2014. “Ruptured

Urinary Bladder Attributable to Urethral Compression by a Haematoma after Vertebral Fracture in a Bull." *Acta Veterinaria Scandinavica* 56 **(**1): 17.

[8] Gugjoo, M. B., Zama, M. M. S., Amarpal, A., Mohsina, A., Saxena, A. C., and Sarode, I. P. 2013. "Obstructive Urolithiasis in Buffalo Calves and Goats: Incidence and Management." *Journal of Advanced Veterinary Research* 3 (3): 109-13.

[9] Kushwaha, R., Kinjavdekar, P., Aithal, H., Pawde, A., and Pratap, K. 2009. "Urolithiasisin Buffalo Calves: A Review of 91 Cases." *Indian Journal of Veterinary Surgery* 30 (1): 9-12.

[10] Mohamed, T., and Oikawa, S. 2008. "Efficacy and Safety of Ultrasound-Guided Percutaneous Biopsy of the Right Kidney in Cattle." *Journal of Veterinary Medical Science* 70 (2): 175-9.

[11] Parrah, J. D., Moulvi, B. A., Hussain, S. S., Bilal, S., and Athar, H. 2011. "Aetiopathogenesis of Bovine Obstructive Urolithiasis." *Indian Journal of Animal Research* 45 (1): 10-7.

[12] Karim, M., Parvin, M., Hossain, M., Islam, M., and Hussan, M. 2014. "A Report on Clinical Prevalence of Diseases and Disorders in Cattle and Goats at the Upazilla Veterinary Hospital, Mohammadpur, Magura." *Bangladesh Journal of Veterinary Medicine* 12 (1): 47-53.

[13] Hesse, A. 2009. *Urinary Stones: Diagnosis, Treatment and Prevention of Recurrence* (3rd ed.). Basel: Karger Medical and Scientific Publishers, 232.

[14] Makhdoomi, D. M., and Gazi, M. A. 2013. "Obstructive Urolithiasis in Ruminants: A Review." *Veterinary World* 6 (4): 233-8.

[15] Singh, R., Sharma, S., Tiwari, D. K., Chaudhary, R. N., Saharan, S., and Pandey, A. K. 2017. "Management of Urinary Obstruction in Buffalo Calves by Tube Cystostomy." *Buffalo Bulletin* 36 (2): 307-12.

[16] Lipismita, S., Ashok, K. P., Chinmoy, M., Biswa, R. M., Laxmi, N. S., and Rubina, K. B. 2011. "Nutritional Strategies to Prevent Urolithiasis in Animals." *Veterinary World* 4 (3): 142-4.

[17] Loretti, A. P., Oliveira, L. O. D., Cruz, C. E. F., and Driemeier, D. 2003. "Clinical and Pathological Study of an Outbreak of Obstructive Urolithiasis in Feedlot Cattle in Southern Brazil." *Pesquisa Veterinária Brasileira* 23 (2): 61-4.

[18] Parrah, J. D., Moulvi, B. A., Hussain, S. S., and Bilal, S., and Ridwana, P. G. 2010. "Comparative Efficacy of Tube Cystostomy and Cystostomy with Indwelling Urethral Catheterization in the Management of Obstructive Urolithiasis in Bovines." *Indian Journal of Veterinary Surgery* 31 (2): 81-5.

[19] Singh, A. K., Gangwar, A. K., and Devil, K. S. 2014. "Incidence and Management of Obstructive Urolithiasis in Buffalo Calves and Goats." *Advances in Animal and Veterinary Sciences* 2 (9): 503-7.

[20] Kannan, K., and Lawrence, K. 2010. "Obstructive Urolithiasis in a Saanen Goat in New Zealand, Resulting in a Ruptured Bladder." *New Zealand Veterinary Journal* 58 (5): 269-71.

[21] Khan, M. A., Makhdoomi, D., Gazi, M. A., Sheikh, G., and Dar, S. 2013. "Clinico-Sonographic Evaluation Based Surgical Management of Urolithiasis in Young Calves." *African Journal of Agricultural Research* 8 (48): 6250-8.

[22] Ewoldt, J. M., Jones, M. L., and Miesner, M. D. 2008. "Surgery of Obstructive Urolithiasis in Ruminants." *Veterinary Clinical North American Food Animal Practice* 24 (3): 455-65.

[23] Bhattacharyya, H. K., Buchoo, B. A., Malik, H. U., and Dar, S. H. 2012. "Management of Obstructive Urolithiasis in Dairy Calves with Intact Bladder and Urethra by Fazili's Minimally Invasive Tube Cystotomy Technique." *Veterinary Science Development* 2 (1): 11.

[24] Sastry, G. A. 1985. *Veterinary Clinical Pathology*. New Delhi: CBS Publishers and Distributors, 4-35.

[25] Kalim, M. O., Zaman, R., and Tiwari, S. K. 2011. "Surgical Management of Obstructive Urolithiasis in a Male Cow Calf." *Veterinary World* 4 (5): 213-4.

[26] Khurma, J., Choudhary, C. R., Vikas Sharma, D., and Singh, K. P. 2017. "Tube Cystostomy for Management of Obstructive Urolithiasis in Buffalo Calves." *International Journal of Science, Environment and Technology* 6 (1): 413-9.

[27] Gugjoo, M., Zama, M., Amarpal, A., Mohsina, A., Saxena, A., and Sarode, I. 2013. "Obstructive Urolithiasis in Buffalo Calves and Goats: Incidence and Management." *Journal of Advanced Veterinary Research* 3 (3): 109-13.

[28] Kushwaha, R. B., Amarpal, H. P. A., Kinjavdekar, P., and Pawde, A. M. 2014. "Clinical Appraisal of 48 Cases of Obstructive Urolithiasis in Buffalo Calves Treated with Tube Cystostomy and Urethrotomy." *Advances in Animal and Veterinary Sciences* 2 (2): 106-10.

[29] Jones, M. L., and Miesner, M. D. 2009. "Urolithiasis." In *Food Animal Practice* (5th ed.), Merchant T. ed., St Louis: Saunders, 322-5.

[30] Radostitis, O. M., Blood, D. C., Gay, C. C., and Hinchcliff, K. W. 2000. *Veterinary Medicine: A Textbook of the Diseases of Cattle, Sheep, Pigs Goats and Horses*,10th ed. London: Bailliere Tindall, 493-8.

[31] George, J. W., Hird, D. W., and George, L. W. 2007. "Serum Biochemical Abnormalities in Goats with Uroliths: 107 Cases (1992-2003)." *Journal of the American*

Veterinary Medical Association 230 (1): 101-6.

[32] Ewoldt, J. M., Anderson, D. E., Miesner, M. D., and Saville, W. J. 2006. "Short and Long Term Outcome and Factors Predicting Survival after Surgical Tube Cystostomy for Treatment of Obstructive Urolithiasis in Small Ruminants." *Veterinary Surgery* 35 (5): 417-22.

[33] Fortier, L. A., Gregg, A. J., Erb, H. N., and Fubini, S. L. 2004. "Caprine Obstructive Urolithiasis: Requirement for 2nd Surgical Intervention and Mortality after Percutaneous Tube Cystostomy, Surgical Tube Cystostomy, or Urinary Bladder Marsupialization." *Veterinary Surgery* 33 (6): 661-7.

[34] Parrah, J. D., Moulvi, B. A., Hussain, S. S., and Bilal, S. 2011. "Innovative Tube Cystostomy for the Management of Bovine Clinical Cases of Obstructive Urolithiasis." *Veterinarski Arhiv* 81 (3): 321-37.

[35] Turk, T., Knoll, A., Petrik, K., Sarica, M., and Straub, C. 2012. "Guidelines on Urolithiasis." *Journal of Endourology* 15 (7): 671-3.

[36] May, K. A., Moll, H. D., Duncan, R. B., Moon, M. M., Pleasant, R. S., and Howard, R. D. 2002. "Experimental Evaluation of Urinary Bladder Marsupialization in Male Goats." *Veterinary Surgery* 31 (3): 251-8.