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Occurrence and Management of Obstructive Urolithiasis in Ruminants

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ABSTRACT

The study was conducted on clinical cases of obstructive urolithiasis in ruminants at SKUAST-Jammu from June, 2014 to May, 2015. A total of 22 cases of surgical affections of urinary tract in ruminants were recorded and 18 cases (81.82%) were in the age group of <6 months. Nineteen cases of obstructive urolithiasis (19/22, 86.36%) were recorded; 10 in buffaloes, five in goats and four in cattle. All the animals affected with obstructive urolithiasis were males, intact 17 (89.47%) and castrated 2 (11.53%). Prevalence of urolithiasis was highest in winter. Cystorrhexis was observed in 47.37% of all cases; 70% in buffaloes and 50% in cattle, whereas all goats had intact bladder. Ultrasonography served as a useful diagnostic aid in assessing urinary bladder, especially in calves and small ruminants. Tube cystostomy was found to be a simple and useful technique in the management of obstructive urolithiasis in small ruminants and buffalo calves with high success rate. Catheter blockade and catheter dislodgment were common post-operative complications following tube cystostomy.

Keywords: Obstructive urolithiasis, tube cystostomy, ultrasonography, ruminants

Affections of urinary tract in ruminants such as congenital anomalies like hypospadias, patent urachus, urethral dilatation, and acquired affections such as obstructive urolithiasis leading to urethral or urinary bladder (UB) rupture have been reported (Ozturk *et al*., 2002; Ranganath *et al*., 2013), but obstructive urolithiasis remains a major problem among ruminants. Urolithiasis is reported worldwide and occurs in all species of animals with equal occurrence in both sexes, however, obstruction is not generally caused in females due to short length and flexible lumen of urethra (Radostits *et al*., 2000). In India, urolithiasis has been reported in bullocks, goat, sheep and buffaloes from across the country with maximal incidence from north and central India (Amarpal *et al*., 2004). Uroliths can lodge anywhere in urinary tract from renal pelvis to glans penis but the common sites of obstruction are distal part of sigmoid flexure and glans penis in bovines (Sharma and Singh, 2001) and urethral process in small ruminants (Kannan and Lawrence, 2010).

Treatment of urolithiasis depends on the value of the affected animal, type of the calculi, and the stage of the disease (Larson, 1996). The aim of treatment of obstructive urethrolithiasis is to relieve the obstruction, correction of defect, re-establishment of urine flow, correction of fluid and electrolyte imbalances and prevention of recurrence. Surgical intervention is the primary step to release the pressure from the bladder or repair the ruptured bladder or urethra. Conventionally, post-scrotal urethrotomy and removal of calculi with subsequent placement of indwelling catheter in the urethra has been the method of choice for surgical treatment of obstructive urethrolithiasis in cattle and buffalo. Urethrostomy has been employed in cases of urethral rupture with necrosis of surrounding tissue. Tube cystostomy, a urinary diversion or urethral bypass technique, has become popular as a treatment for obstructive urethrolithiasis in small ruminants and buffalo calves with subsequent medical dissolution of the urolith (Ewoldt *et al.,* 2006; Kushwaha *et al.*, 2014). The study

was planned to record the occurence, to diagnose and manage urolithiasis in ruminants.

MATERIALS AND METHODS

All the cases brought to Teaching Veterinary Clinical Hospital, SKUAST-J, from June, 2014 to May, 2015, with the history and diagnosis of obstructive urolithiasis were included in the study. Complete history was recorded and general clinical examination was performed. Venous blood samples were collected for hemato-biochemical evaluation. Trans-abdominal ultrasonography was performed using Dynamic imaging ultrasound scanner with 5–6.5 MHz micro-convex transducers to assess urinary bladder (UB) i.e., intact or ruptured, thickness of bladder wall, volume of urine, presence of calculi, if any, presence of fluid in the peritoneal cavity. Urine was collected aseptically from the Foley's catheter or urethral catheter immediately post-operatively for urinalysis. Urine sediment was examined microscopically for casts, pus cells and crystals. The animals were assigned to two groups, those with intact UB (group I) and those with ruptured bladder (group II) for convenience of analysis of results.

Management

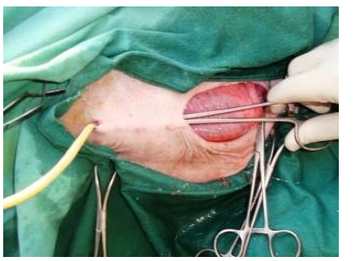
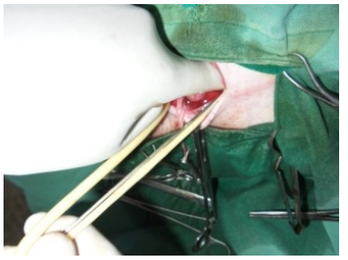
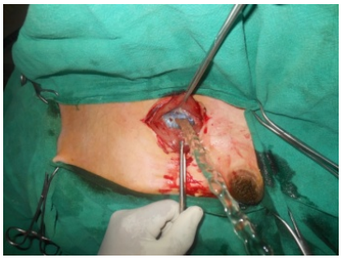
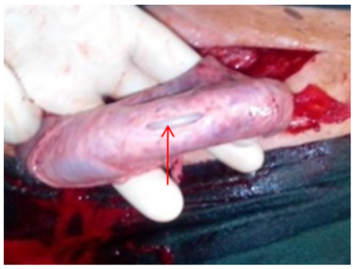
Depending upon the need in individual cases, the animals were managed with tube cystostomy, urethrotomy and partial penectomy+urethrostomy using standard operating procedures (Metre, 2004) with slight modifications depending on the need in each case. For tube cystostomy, a 4-6 cm long skin incision was made about 5 cm lateral and parallel to the penis on the left caudal abdomen to perform tube cystostomy under lumbosacral analgesia with 2% lignocaine HCl @ 1ml/5kg and diazepam sedation @ 0.3mg/kg iv or local infiltration with 2% lignocaine HCl and xylazine sedation @ 0.05 mg/kg im. Peritoneal cavity was entered by separating the abdominal muscles and incising the peritoneum. A straight artery forceps was passed subcutaneously from the incision site anteriorly up to the level of preputial orifice to make a subcutaneous tunnel parallel to the penis, a small nick was made over the skin at the tip of the artery forceps. The tip of the Foley catheter was grasped with the artery forceps through the nick and brought through the tunnel up to the site of incision. In the animals with intact UB, the catheter tip, mounted over a metal rod (blunted 2 mm Steinmann pin) held firmly with the index finger supporting the stretched catheter, was pushed into the UB at its ventro-lateral aspect near the apex with a sudden thrust. The rod was withdrawn and the balloon of the catheter was distended with 15-20 ml normal saline solution. The laparotomy wound was closed in routine manner. The catheter was pulled to appose UB with the abdominal wall and was fixed to the abdominal wall cranial to the nick by 2 to 3 sutures (Fig. 1a-1e). If the UB was ruptured with clear rent, the Cystorrhaphy was performed before tube cystostomy at a separate healthy point (Fig. 2a-2c).

For urethrotomy, the skin incision was made on the midline starting from 1-2 cm caudal to the scrotum after local infiltration. After separating the fascia, the penis was exteriorized with index finger. The incision was made either at the site of palpable calculus or just caudal to the insertion of retractor penis muscles and the calculus was removed. A snugly fitting indwelling catheter (Ryle's tube with tip and adopter transected) was passed in the urethra from the incision site proximally as well as distally and secured to the prepuce after flushing with normal saline in both directions (Fig. 3a-3c).

For urethrostomy, the penis was exteriorized through the post scrotal incision as for urethrotomy, retractor penis muscles were ligated and excised. Sigmoid flexure of the penis was freed. Traction was applied to the penis in caudodorsal direction to free the distal penis from its attachments to the prepuce. The blood vessels on the dorsum of the penis were ligated immediately proximal to the proposed site of penile transaction. The penis was then transected transversally and the distal penis was excised. The stump of the proximal penis was fixed to the skin in a caudoventral direction by a horizontal mattress suture. The urethra was then incised along its long axis on its ventral aspect and resulting urethral mucosal flaps were sutured to the adjacent skin edges by using monofilament nylon in a simple continuous pattern. An infant feeding tube or Ryle's tube of appropriate size with end transected was introduced into the urethra and sutured in place at the edge of the stump (Fig. 4a-4c).

Statistical analysis

The data were statistically analyzed using Independent t-test at 5% level of significance.

		
1a: Restraining of calf in right lateral recumbency for tube cystostomy	**1b:** Ventrolateral prepubic laparotomy incision for tube cystostomy. Bluish structure is peritoneum	**1c:** Insertion of Foley catheter through subcutaneous tunnel
		
1d: Mounting of Foley catheter over blunted Steinmann pin for thrusting into distended bladder	**1e:** Laparotomy wound closure and securing of Foley catheter to the skin	**2a:** Urine draining from peritoneal cavity in case of ruptured urinary bladder
		
2b: Tear on dorsum of urinary bladder in a 4 month old cattle calf	**2c:** Bladder tear repaired before insertion of Foley catheter through a separate stab incision	**3a:** Restraining for post scrotal urethrotomy
		
3b: Urethral catheterisation (arrow)	**3c:** Free flow of urine from urethral catheter	**4a:** Restraining of buffalo bull for urethrostomy. Note swelling cranial to scrotum due to ruptured urethra.

		
4b: Penile stump in buffalo calf following penectomy in case of urethral rupture	**5a:** Excessive straining and tail lifting in a severely dehydrated calf	**5b:** Adherence of sandy material at preputial hair and mucosa
		
5c: Rectal prolapse due to excessive straining in buffalo calf	**5d:** 'Water belly' in a buffalo calf with ruptured urinary bladder	**5e:** Necrosed skin between scrotum and prepucial opening of calf in case of urethral rupture
		
6a: Sonogram of 5 month old buffalo calf showing hyperechoic sludge (S) in distended urinary bladder (UB) forming acoustic shadow (AS)	**6b:** Sonogram of 4 month old buffalo calf showing ruptured urinary bladder (UB) containing small amount of urine and uroperitoneum (F)	**7a:** Urethra filled with sabulous calculi distal to rupture in a buffalo calf

RESULTS AND DISCUSSION

During study period June, 2014 to May, 2015, a total of 22 cases of surgical affections of urinary tract (2.57%) were recorded out of 854 cases of ruminants brought to TVCC of F.V.Sc. & A.H., SKUAST of Jammu out of which obstructive urolithiasis (19/22, 86.36%) was the most common surgical affection of urinary tract (10 buffaloes, 5 goats and 4 cattle). Prevalence of urolithiasis was highest in winter and spring season. Lower hospital incidence of obstructive urolithiasis in the present study (2.22%) when compared with that reported by Kushwaha *et al*. (2009) and Amarpal *et al*. (2013) might be due to the fact that in both of their studies maximum incidence was recorded in goats which could be directly linked to the goat population around the area of study. The actual prevalence of ruminant obstructive urolithiasis or urinary tract surgical affections might be higher than recorded in the present study as many livestock rearers do not report for treatment due to economic problem, lack of awareness about the treatment, or lack of or unaffordable facilities for the transport of animals. Higher incidence of urolithiasis in buffaloes in the present study (52.63%) may also be directly related to

their population in the area under study. All animals were presented with primary complaint of urinary retention, inappetance to complete anorexia, reduced to no water intake, abdominal pain, varying degree of straining, and attempts to urinate. All affected animals had complete urinary retention at the time of presentation except one case of urethral rupture in a buffalo calf where the urine dribbled from the necrosed preputial skin. Defaecation was normal in 15 animals. Three animals (3/19, 15.78%, 2 buffalo calves and 1 cattle calf) passed scanty brown coloured mucous coated dung. There was no defaecation for last 3 days in one animal (buffalo calf).

Clinical signs in animals with intact UB included anuria, inappetance to anorexia, alert to dull and depressed appearance, sunken eyes, dry rough to moist muzzle, frequent attempts to urinate with straining, maintaining urinating posture for prolonged time (Fig. 5a), tail lifting and swishing, adherence of sandy material at preputial hair or mucosa (Fig. 5b), 2-10% dehydration, rectal prolapse due to excessive straining (one case of buffalo calf) (Fig. 5c). Kicking at the belly was observed in one case of bullock. Vocalisation was the most consistent sign in cases of goats. The animals with UB rupture had water belly appearance (Fig. 5d). Animals with ruptured urethra had swelling at the ventral abdomen and prepucial area (Fig. 4a) or necrosis and gangrene of the skin between scrotum and the prepuce (Fig. 5e).

All the cases of urolithiasis were recorded in males in agreement with Radostits *et al*. (2000); 17 of them were intact (1 buffalo bull, 9 buffalo calves, 5 goat bucks and 2 cow calves) and two castrated (bullocks). Ten animals (10/19, 52.63%) had intact UB (group I) and nine animals (9/19, 47.37%) had ruptured UB (group II) at the time of presentation. Cystorrhexis was observed in (7/10, 70%) buffaloes and (2/4, 50%) cattle, whereas all goats (5) had intact bladder. The high incidence of ruptured bladder might be due to delayed presentation of animal, administration of furosemide by paravets and ignorance of the owners. In addition, the concretions might have caused complete obstruction of urethra in buffalo calves leading to bladder rupture (Radostits *et al*., 2000; Sharma and Singh, 2001). Intact UBs at the time of presentation in all bucks might be due to their early reporting due to vocalisation even with slightest discomfort and difficult transportation of large ruminants (Gugjoo *et al*., 2013). The mean duration of illness was 3.36 days (range 2-7 days). It was 3±0.33 days in group I and 3.77±0.52 days in animals of group II. The problem existed for 3-4 days in cattle, 2-7 days in buffaloes and 2-4 days in goats.

Wheat straw, wheat bran, milk, oil cakes, green grass were common ingredients of rations fed to the animals presented with complaint of urinary retention, however, wheat bran was the major constituent of ration of most of the animals. Excess feeding of wheat bran, which is rich in phosphorus and low in calcium, may support the development of phosphate calculi by increasing the precipitation of phosphate salts in urine (Ahmed *et al*., 1989). Obstructive urolithiasis was most common in the age group of 0-6 months. Males of large ruminants are maintained till they are required for milk let down and then disposed off before they attain the age of castration. This could be one of the reasons for higher occurrence of urolithiasis in young and intact males in the study. Urethra was intact in 17 (89.48%) and ruptured in two animals (10.52%, both buffaloes). Higher occurrence was observed in winter which might be due to reduced water intake in winter, a predisposing factor for urolithiasis.

Physiological and heamato-biochemical parameters, ultrasonography and urinalysis

Mean heart rate (83.31±3.19) was higher than the normal reference range in cases of obstructive urolithiasis which could be attributed to the reflex response of baro-receptors and chemo-receptors, sympathetic stimulation or parasympathetic inhibition of SA node (Sobti *et al*., 1986), dehydration, biochemical alterations, inter compartmental fluid shifts, myocardial asthenia (Kelly, 1984). Respiration rate (30.74±1.73) was higher than the normal reference value which could be attributed to pain caused by abdominal crisis and urethral calculi, electrolyte aberrations and hypovolemic shock (Wilson and Lofstedt, 2009). Normal rectal temperature in the cases of urolithiasis in the present study (101.27±0.28^{0}F) corroborated the findings of Tamilmahan *et al*. (2014). All hemato-biochemical parameters viz. Hb, PCV, TLC, DLC, total protein, albumin, AST, and ALT were within normal range except blood urea nitrogen (100.50±8.57 mg/dl) and creatinine (5.43±0.39 mg/dl) which were much higher than the normal reference values, 6-27mg/dl and 1-2 mg/dl, respectively. High BUN and plasma creatinine were in agreement with the findings of Donecker and Bellamy

(1982), Bhokre *et al*. (1985), Tsuchiya and Sato (1990), Sharma *et al*. (2005), Dubey *et al*. (2006), Ewoldt *et al*. (2006), Vinodhkumar *et al*. (2010) and Parrah *et al*. (2011). Urine gets accumulated into the urinary bladder for more than normal period of time in case of urethral obstruction. Thus, the urea and creatinine get reabsorbed into the systemic circulation and causes uraemia. Further, urethral obstruction may cause back flow of urine and create pressure over the kidney to reduce the urine production by decreasing glomerular filtration rate and ultimately decreased urea and creatinine secretion in urine (Sharma *et al*., 2005). BUN and creatinine in the cases of ruptured urinary bladder (group II) were significantly higher (120.52±11 mg/dl and 6.40±0.34 mg/dl, respectively) than that in group I, the intact bladder cases (82.48±11.84 mg/dl and 4.56±0.58 mg/dl, respectively) $p<0.05$, which could be due to easy movement of urea and creatinine across concentration gradient from peritoneal cavity to the interstitial and intravascular compartments (Donecker and Bellamy, 1982).

Ultrasonography proved to be highly useful, non invasive and inexpensive tool to confirm the status of UB in obstructive urolithiasis. Intact UB appeared as anechoic fluid filled distended round body along with distended pelvic urethra (Fig. 6a). In the animals suspected with ruptured UB or those with ruptured urethra, the UB was very small to moderate sized, thick walled, containing small amount of anechoic urine with or without uroperitoneum (Fig. 6b). Multiple, minute hyperechoic free floating structures scattered throughout the contents of the UB, especially in the far field were seen in all cases irrespective of the size of the UB indicative of the cellular debris due to cystitis (Braun *et al*., 1992). The hyperechoic structures in the far field that produced acoustic shadow (Fig. 6a) and changed shape and position in three cases indicated presence of numerous concretions each about 1mm in size in the UB which were confirmed on cystostomy. History of urine retention for several days, detection of UB containing small amount or no urine and free anechoic fluid in the peritoneal cavity were confirmative of bladder rupture.

There was great variation in the color of urine, probably due to variation in concentration of urine, accumulation of sediment and haemorrhage. Yellow colored urine with turbidity was probably due to presence of sabulous material in the UB. Brownish colored urine indicated blood in urine, whereas dark yellow colored urine indicated concentrated urine due to more duration of illness. Results of urinalysis are presented in Table 1.

Table 1: Mean values of different parameters for urine analysis and microscopic examination

Parameters	All Cases (n=19)	Group 1- Intact urinary bladder (n=10)	Group 2- Ruptured urinary bladder (n=9)
Urine pH	8.13 ± 0.05	8.15 ± 0.07	8.11 ± 0.07
Specific Gravity	1.0139 ± 0.001	1.014 ± .001	1.0139 ± 0.002
Sediment score*	1.26 ± 0.12	1.30 ± 0.21	1.22 ± 0.14
Cast score[#]	0.79 ± 0.12	0.80 ± 0.13	0.77 ± 0.22
Pus Cells score[§]	0.73 ± 0.15	0.60 ± 0.20	0.89 ± 0.20
Crystals score[a]	2.05 ± 0.16	2.20 ± 0.20	1.89 ± 0.26

* 0 (no sediment), +1 (mild sediment), +2 (moderate sediment), and +3 (heavy sediment).

[#] 0 – normal casts (0-2 casts per hpf), 1-mild casts (2-5 casts per hpf), 2-moderate casts (5-10 casts per hpf), and 3- heavy casts (>10 casts per hpf).

[§] 0-normal (0-2 pus cells per hpf), +1-mild (2-5 pus cells per hpf), +2-moderate (5-10 pus cells per hpf), and +3- heavy (>10 pus cells per hpf).

[a] 0-normal (no crystals), +1-mild, +2-moderate and +3-heavy crystal deposition depending on the quantity present in low power field.

The 'moderate' sediment score was probably due to presence of suspended particles and epithelial cells due to long standing obstruction. The 'mild' mean pus cell score indicated pus cell/leukocytes in the urine of affected animals, indicating inflammatory exudation at some point in the urinary tract, usually the renal pelvis or bladder (Radostits *et al*., 2009). Moderate to heavy crystalluria was in agreement with the findings of Kinjavdekar *et al*. (2005). Struvite and calcium phosphate were the most common type of crystals found in the present study. Struvite and calcium phosphate crystals might have developed due to feeding of high phosphorus diets (wheat bran and concentrate).

Furthermore, alkaline pH of urine favours the formation of phosphate and struvite calculi (Pugh, 2002). The difference in pH, specific gravity, sediment score, cast score, pus cell score and crystal score between two groups were not significant ($p>0.05$).

Management

Out of nineteen cases of obstructive urolithiasis, a total of 15 (15/19, 78.94%) animals with intact urethra were managed by tube cystostomy. Out of the 15 cases, seven cases (46.66%) with intact UB (5 goats, 1 buffalo calf and 1 cow calf) and 4 (26.66%) with subserous rupture (3 buffalo calves and 1 cow calf), were managed by tube cystostomy alone. Free flow of urine from Foley catheter was noticed in all the cases with intact UB or those with subserous rupture and when the urine got filtered through the surgical drapes, sand like concretions were seen on the drape in all the cases. About 200 ml to 2 L of urine was drained in these animals. The remaining four cases (26.66%) with ruptured UB (buffalo calves) were managed by tube cystostomy followed by cystorrhaphy and about 3-8 L of urine was drained out from the peritoneal cavity by abdominocentesis and through the surgical incision.

One bullock with intact UB and urethra was managed by post-scrotal urethrotomy. In the second bullock with ruptured UB, postscrotal urethrotomy and cystorraphy were planned and approx. 20 L of urine was drained slowly by abdominocentesis before casting. The animal died after urethrotomy, before cystorraphy could be performed. In both of these cases, well formed single calculus was seen lodged at the distal bend of sigmoid flexure just proximal to insertion of retractor penis muscles. The reason for performing post scrotal urethrotomy in both of these cases was the fact that distal bend of sigmoid flexure has been reported to be the most common site of calculi lodgment in adult male cattle and buffaloes and retrieval of well formed calculi from these cases was in agreement with Radostits *et al*. (2009), Sharma and Singh (2001) and Kushwaha *et al*. (2014).

Two cases of urethral rupture (2/19, 10.52%, one buffalo bull and one buffalo calf) were managed by performing partial penectomy and perineal urethrostomy. A considerable portion of penis was necrosed in both the cases. In case of buffalo calf, skin between the scrotum and the prepucial opening was severely necrosed and gangrenous due to cellulitis (Fig. 5e). These findings are in agreement with Radostits *et al*. (2009). Solidified sabulous calculi were retrieved from the tissues in the pre-scrotal area and entire urethra distal to rupture was filled with sabulous calculi (Fig. 7a) which corroborated with the findings of Sharma and Singh (2001) who reported that in buffalo calves, most of the calculi present were sandy in nature and occupied long distance contrary to adult buffalo or bullock where single calculus was the cause of obstruction. No calculus could be retrieved in case of the buffalo bull.

Post-operative observations/complications

With tube cystostomy, mean time of initiation of dribbling of urine from natural urethral orifice (7.9±0.93 days; range 5-15 days) and mean time of initiation of free flow of urine from natural opening (9.4±0.75 days; range 7-15 days) were in agreement with the findings of Rakestraw *et al*. (1995), Ewoldt *et al*. (2006), Parrah *et al*. (2011) and Fazili *et al*. (2012). Mean time of removal of Foley catheter (12.7±0.73 days; range 10-18 days) was almost similar to that reported by Rakestraw *et al*. (1995) and Singh *et al*. (2014). Post operative blockade of Foley catheter in two cases on 2nd and 3rd day of surgery might have occurred by urine sludge, blood clot or calculi, and was managed by flushing of the catheter with normal saline.

Overall success rate with tube cystostomy (73.33%) was similar to that reported by Ewoldt *et al*. (2006) but was lower than most of the earlier reports (Singh *et al*., 2010; Tamilmahan *et al*., 2014). The reason for lower success rate might be delayed presentation of the cases, improper post operative care by animal owners, differences in the nature and severity of lodgement of calculi and incomplete follow up of the cases. Follow up of two cases (13.33%) was not known and two cases (13.33%) died following dislodgement of Foley catheter.

CONCLUSION

Ultrasonography proved to be a very useful aid in diagnosis of urolithiasis (assessing UB condition) especially in calves and small ruminants where rectal examination could not be performed. Tube cystostomy was found to be a simple, useful technique in the management of obstructive urolithiasis in calves and small ruminants with overall success rate of 73.33%.

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