Clinicophysiological Alterations in Clinical Cases of Bovine Obstructive Urolithiasis

J. D. Parrah, B. A. Moulvi, S. S. Hussain and J.I.A. Bhat
Division of Veterinary Surgery and Radiology, F. V. Sc & A.H., SKUAST-K, Shalimar, Srinagar, J&K

ABSTRACT

Urolithiasis in ruminants, especially in cattle, is of considerable economic importance as losses inflicted by this melody are considered very high. Investigations on clinical studies on obstructive urolithiasis in cattle calves, recorded from August 2005 – July 2007 at Teaching Veterinary Clinical Service Complex of SKUAST- K, were carried out with the objectives of studying the alterations in clinicophysiological parameters of the disease. Thirty clinical cases of obstructive urolithiasis with 15 ruptured and 15 intact urinary bladders were brought to the clinics for the treatment during the study period. Diagnosis of the disease was made on the basis of history of anuria, clinical signs, radiographic, ultrasonographic, haematobiochemical, and peritoneal fluid examinations. The general condition and demeanor in the clinical cases of obstructive urolithiasis ranged from fair to recumbency. The common clinical signs recorded in calves were anuria, inappetance to anorexia, restlessness, depression, sunken eyes, reluctance to move, kicking at the ventral abdomen, tendency to rectal prolapse, concretion encrustation at prepucial hairs, tachycardia, tachypnoea etc. On the basis of frequency of repetition of symptoms in the cases of this study tachycardia, tachypnoea, anorexia, restlessness, and concretion encrustation at prepucial hairs ranked Ist, 2nd, 3rd, 4th, and 5th clinical symptom. The clinical signs varied according to the status of the urinary bladder. In cases with ruptured urinary bladder, bilateral distension of abdomen (water belly) was a consistent finding. The HR and RR were elevated above the reference value, whereas RT was within the normal range. All the physiological parameters were higher in ruptured urinary bladder cases than those in the cases with intact urinary bladder.

Key word: Calf, occurrence, urolithiasis, urine

INTRODUCTION

Obstructive urolithiasis means the formation of calculi in the urinary tract with subsequent urinary blockade by uroliths (Emerick, 1988; Payne, 1989; Radostits *et al.*, 2000a). The disease inflicts heavy losses to the livestock owners as it is attributed to the fifth most prevalent cause of death in feedlot (Salman, 1988). Obstructive urolithiasis, can rapidly progress to bladder or urethral rupture, uremic crisis and death (Baxendell, 1984). Urolithiasis in ruminants, especially in cattle, is of considerable economic importance in countries like India where cattle - based agriculture is strongly linked with the livelihood of an important segment of the population. Obstructive urolithiasis is often difficult to detect until it is life threatening because the clinical signs can be quite variable depending upon duration, extent (partial or complete) and location of obstructing urolith. The condition is thus diagnosed by history of anuria coupled with other clinical manifestations and abdominocentesis. The tentative diagnosis is usually confirmed by imaging techniques especially ultrasound examination. Urolithiasis is a multi-factorial condition due to combined influences of physiological, nutritional and managemental factors. It is mainly attributed to excessive or imbalanced intake of minerals (McIntosh, 1978; Larson, 1996; Radostits *et al.*, 2000a). Individual species have thus been observed to demonstrate one or two particular types of stones with high frequencies. The chemical composition of urinary calculi varies and depends largely on the dietary composition of individual elements, the geographical location and local managemental practices (Singh and Singh, 1990). This attempt was thus undertaken to study the alterations in clinico physiological parameters of obstructive urolithiasis in cattle of Kashmir under temperate managemental conditions.

MATERIAL AND METHODS

Thirty male cattle calves, suffering from complete retention of urine, presented for treatment at Teaching Veterinary Clinical Services Complex, Faculty of Veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar, formed the material of the study. At the time of admission, all the animals were subjected to complete pre-operative evaluation. A complete history regarding the age, breed and sex of the animal, castration and age at the time of castration, duration of illness, managemental practices, feeding habits of the animal, early signs of the disease, previous treatment, if any, were recorded. These animals were subjected to radiographic, ultrasonographic, haematobiochemical, and peritoneal fluid examinations for confirmation of the tentative diagnosis and recording the status

of the urinary bladder. The confirmed bovine patients suffering from complete retention of urine were then subjected to complete clinical examination. The alterations in physiological parameters and other signs exhibited by the animals were recorded. These observations included heart rate (beats/min), respiration rate (breaths/min), rectal temperature (°F), skin fold test time (seconds), extent of dehydration, condition of the eye ball (sunken/normal) and general body condition (fair/dull and depressed/recumbent), besides other clinical signs exhibited by the calves were recorded. Dehydration percentage was estimated by skin fold test at the site of neck following the criteria of Radostits *et al.* (2000b), as:

Skin fold test time (Seconds)	Corresponding dehydration extent (Percent)
>2	4 – 6
2 – 4	6 – 8
6 – 10	8 – 10
20 – 45	10 – 12

The data thus obtained was classified and subjected to statistical analysis as per the standard procedures (Snedecor and Cochran, 1976) and inferences drawn.

RESULTS AND DISCUSSION

The general condition and demeanour in the clinical cases of obstructive urolithiasis was fair in 19 cases (11 with intact and 8 with ruptured urinary bladder), dull and depressed in 9 cases (4 with intact and 5 with ruptured urinary bladder) and recumbent 2 cases only (with ruptured urinary bladder) (Table 1). The general body condition was thus mainly associated with the status of urinary bladder (rupture or intact). Duration of illness had also profound effect on the

Table 1. Distribution of obstructive urolithiasis cases according to the general body condition with regard to status of urinary bladder

General condition	Overall Position (N=30)		Intact Bladder (N = 15)			Ruptured bladder (N= 15)		
	No. of animals	%	No. of animals	Overall % (n= 30)	Subgroup % (n= 15)	No. of animals	Overall % (n= 30)	Subgroup % (n= 15)
Fair	19	63.33	11	36.66	73.33	8	26.66	53.33
Dull and depressed	9	30.00	4	13.33	26.66	5	16.66	33.33
Recumbent	2	6.66	0	0.00	13.33	2	6.66	13.33
Total	30	100	15	50	100	15	50	100

body condition. General body condition was found fair in the cases that had diseases for 24 – 96 hours, dull and depressed in those cases that had illness for 48 – 120 hours. Two recumbent cases had illness for 52 and 128 hours respectively. Hooper (1998), Radostits *et al.* (2000a) and Smith (2002) also reported depression in obstructive urolithiasis and recumbency in uraemia following rupture of bladder.

The clinical symptoms exhibited by the clinical cases of obstructive urolithiasis are depicted in Table 2. The clinical signs varied according to the

Table 2. Clinical symptomatology of obstructive urolithiasis cases

S.No	Symptoms	Overall (N=30)		Intact Bladder (N=15)			Ruptured Bladder (N=15)			
		No.	%age	Rank	No.	%age	Rank	No.	%age	Rank
1.	Anorexia	25	83.33	III	11	73.33	III	14	93.33	II
2.	Kicking at belly	9	30.00	VIII	9	60.00	IV	00	0.00	XI
3.	Treading with hind feet	8	26.66	IX	8	53.33	V	00	0.00	XI
4.	Swishing of tail	6	20.00	XI	6	40.00	VII	00	0.00	XI
5.	Restlessness	21	70.00	IV	14	93.33	II	7	46.66	VI
6.	Grinding of teeth	12	40.00	VI	8	53.33	V	4	26.66	IX
7.	Tendency of rectal prolapse	4	13.33	XII	4	26.66	VIII	00	0.00	XI
8.	Mild bloat	12	40.00	VI	7	46.66	VI	5	33.33	VIII
9.	Bilateral abdominal distension	10	33.33	VII	0	0.00	XI	10	66.66	V
10.	Concretion encrustation at prepucial orifice	14	46.66	V	7	46.66	VI	7	46.66	VI
11.	Swelling on ventral abdomen	3	10.00	XIII	3	20.00	IX	00	0.00	XI
12.	Straining for urination	7	23.33	X	7	46.66	VI	00	0.00	XI
13.	Urethral thrill	8	26.66	IX	8	53.33	V	00	0.00	XI
14.	Fluid thrill at abdominal ballottement	12	40.00	VI	0	0.00	X	12	80.00	IV
15.	Arched back	9	30.00	VIII	9	60.00	IV	0	0.00	XI
16.	Uraemic breath	7	23.33	X	0	0.00	XI	7	46.66	VI
17.	Depression	9	30.00	VIII	4	26.66	VIII	5	33.33	VIII
18.	Recumbency	2	6.66		0	0.00	XI	2	13.33	X
19.	Hypothermia	7	23.33	X	2	13.33	X	5	33.33	VIII
20.	Tachycardia	30	100.00	I	15	100.00	I	15	100.00	I
21.	Tachypnoea	27	90.00	II	14	93.33	II	13	86.66	III
22.	Reluctant to move forward	6	20.00	XI	0	0.00	XI	6	40.00	VII

status of the urinary bladder and duration of urethral obstruction.

The clinical signs exhibited by the cases with intact urinary bladder included kicking at belly (9; 60%), treading with hind feet (8; 53.33%), swishing of tail (6; 40%), tendency of rectal prolapse (4; 26.66%), straining for urination (7; 46.66%), urethral thrill (8; 53.33%) and arched back (9; 60%). Pulsation of urethra and rectal prolapse could probably be due to continuous efforts made by the animals for urination. Kicking at belly, treading with hind feet, swishing of the tail and arched back point to the discomfort felt by the animal due to the distension of the bladder. Monoghan and Boy (1990) opined that early signs of urethral obstruction are caused by the urethral pain. Once urinary bladder or urethra ruptures, these symptoms wane away and those of uraemia supervene. Similar signs have been reported by Oehme and Tillman (1965), Hayashi *et al.* (1979), Jensen and Mackey (1979), Hofmeyr (1987), Hooper (1998), Radostits *et al.* (2000a), Smith (2002), Loretti *et al.* (2003) and Villar *et al.* (2003) in cases with obstructive urolithiasis.

The symptoms exhibited by the cases with ruptured urinary bladder included bilateral abdominal distension (10; 66.66%), fluid thrill at abdominal ballottement (12; 80%), uraemic breath (7; 46.66%), recumbency (2; 13.33%), and reluctance to move (6; 40%). Bilateral abdominal distension usually occurs due to accumulation of urine in the peritoneal cavity. The high degree of abdominal distension makes the animal reluctant to move probably because of the discomfort caused by turbulence of excessive peritoneal fluid. Similar types of clinical signs had also been reported by various investigators (Monoghan and Boy, 1990; Radostits *et al.*, 2000a; Walker and Hull, 1984).

The clinical signs exhibited by the animals of both the groups (intact and ruptured urinary bladder) included anorexia (25; 83.33%), restlessness (21; 70%), grinding of teeth (12; 40%), mild bloat (12; 40%), concretion encrustation at prepucial orifice (14; 46.66%), depression (9; 30%), hypothermia (7; 23.33%), tachycardia (30; 100%) and tachypnoea (27; 90%) cases. Tachycardia, tachypnoea, anorexia, restlessness, and concretion encrustation at prepucial orifice ranked 1st, 2nd, 3rd, 4th and 5th clinical symptom respectively exhibited by the cases of this study. The findings match with those of Muhee (2006).

Three (10%) ruptured urethra cases characterised by severe swelling on ventral abdomen due to excessive subcutaneous accumulation of urine were recorded during this study (Fig. 1). In one ruptured urethra case there was severe discoloration of overlying skin, indicative of setting of necrosis due to protractedness of the case (Fig. 2); while in another case there was severe posthitis due to reported application of chilli at the site (Fig. 3).

Fig. 1. Calf showing urethral rupture

Fig. 2. Subcutaneous urine accumulation with necrosed overlying skin

Fig. 3. Severe posthitis due to application of chilli

The values for different physiological parameters are depicted in Table 3.

The mean ± SE rectal temperature (°F) in the affected calves was 101.26 ± 0.20 with a range of 99.5 to 102.8 °F. The comparative mean ± SE values for rectal temperature (°F) recorded in cases of obstructive urolithiasis with intact and ruptured bladder with non significant ($p<0.05$) differences were 101.38 ± 0.29 (99.5-102.9 °F) and 101.14 ± 0.30 (99.5-102.8 °F) respectively. All these values were within normal reference range (101.8 - 102.4°F). The rectal temperature in intact urinary bladder cases was slightly higher than the cases with ruptured urinary bladder. However in 7 cases of the present study hypothermia was recorded at the time of admission. The variation in the RT could probably be due to the variation in the stage of uraemia, duration of illness and degree of hemodynamic changes. These findings are in total agreement with those of Sockett

et al. (1986) who reported normal body temperature as well as hypothermia in cases with obstructive urolithiasis. Hypothermia is indicative of shock (Sockett, *et al.*, 1986; Radostits *et al.*, 2000a). Smith (2002) also reported no alteration in body temperature in animals with obstructive urolithiasis. Gangwar *et al.* (1990) also found no change in the values of RT after experimental creation of urethral obstruction in cattle calves. However the findings of the present study differ with those of Jadon *et al.* (1987) and Singh and Sahu (1995) who respectively recorded increased and decreased levels of RT in experimentally induced urethral obstruction in buffalo calves. Kulkarni *et al.* (1985) recorded variable RT in cattle calves.

The mean ± SE respiratory rate (breaths / minute) in this study was 29.9 ± 1.87 with a range of 15 - 69 breaths / minute. In cases with intact urinary bladder, mean ± SE respiratory rate (breaths / minute) was 26.73 ± 1.20 with a range of 15 - 31 breaths/ minute. However, the mean ± SE respiratory rate in the calves suffering from obstructive urolithiasis with ruptured urinary bladder was 33.00 ± 3.40 breaths / minute with a range of 19 - 69 breaths / minute. All these values were higher than the normal reference range (12 – 16 breaths / minute). Comparatively the values in the cases with ruptured urinary bladder were higher than in the cases with intact urinary bladder, but the difference was statistically nonsignificant ($p<0.05$). Higher mean respiratory rate than the normal reference value recorded during this study corroborate well with Hooper (1998) and Smith (2002). Increased respiratory rate could be attributed to toxaemia as a result of retention of metabolic waste products during obstructive urolithiasis. Higher respiratory rate could also be due to pain caused by urethral calculi, abdominal crisis, electrolyte aberrations like hypocalcaemia, hypomagnesaemia and hypovolumic shock (Wilson and Lofstedt, 1990). However, Radostits *et al.* (2000a) attributed the increased respiratory rate in uraemic animals to dehydration, myocardial asthenia, with hyponatraemia and hyperkalaemia as main causes. Earlier researchers also had recorded elevated respiratory rate in uraemia in buffalo calves (Jadon *et al.*, 1987), sheep (Joshi *et al.*, 1989) and goats (Tsuchiya and Sato, 1988). The respiratory rate was further higher in the cases of ruptured urinary bladder. This could be attributed to the pressure excreted over diaphragm by accumulated urine in the peritoneal cavity and to the severe systemic changes influenced by excessive accumulation of metabolic waste products like BUN and creatinine (Reddy, 1992; Monoghan and Boy, 1990). However, the findings of the present study differ from those of Singh and Sahu (1995) who observed decreased respiratory rate in experimentally induced uraemia in buffalo calves.

The value of heart rate in the present study ranged between 78 - 125 beats/

minute with mean ± SE as 101.33 ± 2.46 beats/minute. The mean ± SE heart rate in the cases with intact urinary bladder was 98.87 ± 2.30 beats/minute with the range of 78 - 109 beats/minute. Animals with ruptured urinary bladder had nonsignificantly higher mean ± SE heart rate as 103 8 ± 4.30 beats/minute with the range of 78 - 125 beats / minute. The mean ± SE heart rate was higher in both the groups than the normal reference value (72 – 84 beats/minute). Bradycardia was not observed in any case. The higher mean heart rate recorded in the present study is in total accordance with the observations of early workers (Jadon *et al.*, 1987; Joshi *et al.*, 1989; Monoghan and Boy, 1990; Tsuchiya and Sato, 1988; Singh, 2005; Hooper 1998; Smith 2002, Singh and Sahu 1995). Increased heart rate could be attributed to the reflex response of baro-receptors and chemo-receptors, sympathetic stimulation or para-sympathetic inhibition of SA node (Sobti *et al.*, 1986), progressive hyperkalaemia (Sharma *et al.*, 1982; Bhokre and Deshpande, 1987), dehydration, biochemical alterations, inter-compartmental fluid shifts and myocardial asthenia (Kelly, 1984), accumulation of toxic metabolic waste products (Lavania *et al.*, 1973), pain and progressive systemic disturbances (Monoghan and Boy, 1990). Inappetance and prolonged duration of illness and myocardial asthenia resulting from hyponatraemia and hyperkalaemia in ruminants could also be the possible causes of increased heart rate in the cases of obstructive urolithiasis (Radostits *et al.*, 2000a). However, Gangwar *et al.* (1990) found decreased heart rate in the cases of urolithiasis. The stage of uraemia or duration of illness could be the factors responsible for variation in the heart rate. Increase in heart rate was more in the cases of ruptured urinary bladder than the cases with intact urinary bladder, which might be due to the fact that systemic changes and accumulation of waste products could be more in the cases of ruptured urinary bladder (Lavania *et al.*, 1973).

The mean ± SE time of skin fold test was 4.87 ± 0.47 seconds with the values ranging in between 2-10 seconds. The mean ± SE time of skin fold test in calves with intact urinary bladder and ruptured urinary bladder was 4.40 ± 0.61 and 5.33 ± 0.71 seconds respectively. However, the range of values was same in both the groups as 2-10 seconds. All the values were profoundly higher than normal instantaneous return values of skin fold.

The extent of dehydration in calves of this study suffering from obstructive urolithiasis varied from 4- 10 % (Table 3). In cases of intact urinary bladder, 2 calves had 4—6 %, 6 calves had 6 – 8 % and 7 calves had 8- 10 % dehydration. In this group too, the extent of dehydration varied from 4 – 10 %. However, in cases of ruptured urinary bladder, the extent of dehydration varied from 6 – 10 %. In this group 9 calves had 6 – 8 % and 6 calves had 8- 10 % dehydration.

Table 3. Comparative physiological values in different groups of obstructive urolithiasis cases

Parameters	Whole group (N = 30)		Intact bladder (N = 15)		Ruptured bladder (N = 15)		Normal reference values
	Mean ± SE	Range	Mean ± SE	Range	Mean ± SE	Range	
RT (°F)	101.26 ± 0.20	99.5 - 102.8	101.38 ± 0.29	99.5 - 102.9	101.14 ± 0.30	99.5 - 102.8	101.8 - 102.4[#]
RR (Breaths/m)	29.9 ± 1.87	15 - 69	26.73 ± 1.20	15 - 31	33.00 ± 3.40	19 - 69	12 - 16[#]
HR (Beats/m)	101.33 ± 2.46	76 - 125	98.87 ± 2.30	76 - 109	103.6 ± 4.30	78 - 125	72 - 84[¶]
STT (Seconds)	4.87 ± 0.47	2 - 10	4.40 ± 0.61	2 - 10	5.33 ± 0.71	2 - 10	Instantaneous return[¶]

RT= Rectal temperature; RR= Respiratory rate; HR = Heart rate; STT= Skin tent test [#] Sastry, 1983; ¶ Radostits *et al.*, 2000[a]

The skin tent test and percent dehydration are closely related to each other as the loss of skin elasticity is primarily due to loss of fluid from the interstitial and intracellular spaces (Radostits *et al.*, 2000a). Dehydration is detectable only when at least 4 – 5 % of body weight is lost in water. An acute loss of more than 12 % of body water is life threatening (Doxey, 1983; Chew and Bateman, 1999; Radostits *et al.*, 2000a). Moderate degree of dehydration (4- 10 %) was recorded in this study, which could be due to depressed appetite and thirst centres of systemically ill animals due to toxaemia or due to deliberate deprivation of feed and water (Chew and Bateman, 1999; Radostits *et al.*, 2000a). The percent dehydration was more in the cases of ruptured urinary bladder during this study. It could be due to accumulation of urine in abdominal cavity. Since urine has low concentration of sodium and chloride, these electrolytes diffuse from blood to the abdomen following concentration gradient (Donecker and Bellamy, 1982). With increased levels of sodium and chloride in peritoneal fluid, water moves out of intracellular, extracellular and intravascular compartments into the abdomen, thus creating dehydration and poor circulation (Sockett *et al.*, 1986; Larson, 1996).

REFERENCES

Baxendell, S. A. 1984. Urethral calculi in Goats. In: University of Sydney Post-Graduate Committee in Veterinary Science Refresher Course for Veterinarians. Proceedings No. 73: 495-497

Bhokre, A. P. and Deshpande, K. S. 1987. Experimental studies on peritonitis in buffalo

calves. *Indian Vet. J.*, **64**: 137-141.

Chew D. J. and Bateman, S. W. 1999. Fluid therapy for dogs and cats. Saunders Manual of Small Animal Practice, by Birchard, S. J. and Sherding, R. G. 2nd ed. pp 64-78.

Donecker, J. M. and Bellamy, J. E. C. 1982. Blood chemical abnormalities in cattle with ruptured bladder and ruptured urethra. *Can. Vet. J.*, **23**: 355-357.

Doxey, D. L. 1983. Clinical pathology and diagnostic procedures. Bailliere Tindal Ltd.

Emerick, R. J. 1988. Urinary Calculi. In: *The Ruminant Animal: Digestive Physiology and Nutrition*. Prentice Hall, New Jersy, pp 523-528.

Gangwar, S. D., Pandey, N. N. and Celly, C. S. 1990. Clinico haematological profile of calves in experimental uraemia of post renal origin. *Indian Vet. J.*, **67**:645-648.

Hayashi, M., Ide, Y., Shoya, S., Enomoto, C. and Mizoguchi, H. 1979. Observation of xanthinuria and xanthine calculosis in beef calves. *J. J. Vet. Sci.*, **41**(5): 505-510.

Hofmeyr, C. F. B. 1987. *Ruminant Urogenitol Surgery*. Iowa State University Press, pp 15-28.

Hooper, N. R. 1998. Management of urinary obstruction in small ruminants. *Proceeding. Western Veterinary Conference*, pp 99-106.

Jadon, N. S., Prakash, P., Joshi, H. C. and Kumar, A. 1987. Clinico haematological changes in experimental urethral obstruction in buffalo calves. *Indian Vet. J.*, 7:49-51.

Jensen, R. and Mackey, D. R. 1979. *Diseases of feedlot cattle*. 3rd Ed. Philadelphia, Lea and Febiger, pp 262-267.

Joshi, H. C., Zangana, I. K. and Saleem, A. N. 1989. Haematobiochemial and electrocardiographic changes in uraemia in sheep. *Indian Vet. J.*, 9: 69-73.

Kelly, W. R. 1984. Veterinary Clinical Diagnosis. 3rd Ed. William Clowes Limited, Beccles and London.

Kulkarni, B. B., Chandna, I. S., Peshin, P. K., Singh, J. and Singh, A. P. 1985. Experimental evaluation of treatment of uraemia due to ruptured urinary bladder in calves-I. Conventional Treatment. *Indian Vet. Surg.*, **6**(1): 19-24.

Larson, B. L. 1996. Identifying, treating and preventing bovine urolithiasis. *Vet. Med.*, **91**: 366-377.

Lavania, J. P., Misra, S. S. and Angelo, S. J. 1973. Repair of rupture of bladder in a calf – a clinical case. *Indian Vet. J.*, **50**: 477-481.

Loretti, A. P., Oliveira-Lo,de., Cruz, C.E.F., Driemeier, D. and De-Oliveira, Lo. 2003. Clinical and pathological study of an outbreak of obstructive urolithiasis in feedlot cattle in southern Brazil. *Pesquisa Veterinoria-Brasileiro*, **23**(2):61-64.

McIntosh, G. H. 1978. Urolithiasis in Animals. *Aus. Vet. J.*, **54**: 267-271.

Monoghan, M. L. and Boy, M. G. 1990. Ruminants Renal System: Diseases of the renal system. In: Large Animal Internal Medicine. Eds. B.P. Smith, C.V Mosby Company, Philadelphia. Toronto, pp 888-890.

Muhee, A. 2006. Prevalence and clinical management of obstructive urolithiasis in cattle calves. Thesis submitted to Sher-e-Kashmir University of Agricultural Sciences

and Technology of Kashmir for the partial fulfilment for the award of MVSc degree.

Oehme, F. W. and Tillmann, H. 1965. Diagnosis and treatment of ruminant urolithiasis. *JAVMA*, **147**:1331-1339.

Payne, J. M. 1989. *Metabolic and Nutritional Diseases of Cattle*. Blackwell, Oxford, pp 41-44.

Radostits, O. M., Blood, D. C., Gay, C. C. and Hinchcliff, K. W. 2000(a). *Veterinary Medicine: A Textbook of the Diseases of Cattle, Sheep, Pigs, Goats and Horses*. Bailliere Tindall, London, pp 493-498.

Radostits, O. M., Mayhem, I. G. J. and Houston, D. M. 2000(b). *Veterinary Clinical Examination and Diagnosis*. W B Saunders Philadelphia, New York.

Reddy, Y. K. 1992. A comparative study on peritoneal and pleural dialysis in the management of uraemia following urinary bladder rupture in goats. M.V.Sc thesis submitted in surgery to the deemed university, IVRI, Izatnagar, U.P.

Salman, M.D. 1988. Rates of diseases and their associated costs in two Colorado feedlots (1985-1986). *Journal of American Veterinary Medical Association*, **193**:1518-1523.

Sharma, S. N., Prasad, B., Kohli, R. N. and Singh, J. 1982. Pathophysiology of bovine uraemia. *Indian Journal of Animal Sciences*, **52**: 643-649.

Singh, H. and Sahu, S. 1995. Peritoneal lavage as an adjunct therapeutic measure for uraemia in bovines. *Indian Vet. J.*, **72**(11): 1174-1176.

Singh, J. and Singh, K. 1990. Obstructive urolithiasis and uraemia in cattle and buffalo-a review. *Indian Vet. Surg.*, **11**: 1-20.

Smith, B. P. 2002. Large *animal Internal Medicine*. Ed. 3rd, Mosby, Inc. pp.853.

Snedecor, G. W. and Cochran, W. G. 1976. Statistical Methods. Iowa State University Press, pp 20-28, 58-59.

Sobti, V. K., Jalaludin, A. M., Kumar, V. R. and Kohli, R. N. 1986. Electrocardiographic changes following experimental rupture of urinary bladder in calves. *Indian J. Vet. Surg.*, **7**: 36-41.

Sockett, D. C. Knight, A. P., Fettman, M. J., Kichl, A. R., Smith, J. A. and Arnold, S. M. 1986. Metabolic changes due to experimentally induced rupture of the bovine urinary bladder. *Cornell Veterinarian*, **76**: 198-212.

Tsuchiya, R. and Sato, M. 1988. Prevalence and control of urolithiasis in fattening cattle. *JVMA.*, **41**(1): 36-39.

Villar, D., Larson, D. J., Janke, B. H., Yaeger, M. J., Carson, T. L. and Blaylock, R. 2003. Case report- obstructive urolithiasis in a feedlot steer. *Bovine – practitioner*, **37** (1): 74-77.

Walker, D. F. and Hull, B. L. 1984. Bovine urogenital surgery. Cited by Jennings, J.R., The practice of large animal surgery, **2**: 1042-1079.

Wilson, W. D. and Lofstedt, J. 1990. *Alterations in respiratory functions*. In: Large Animal Internal Medicine, by Smith, B.P., C. V. S. Mosby Co., pp 47-99.