# DIAGNOSTIC EVALUATION OF THE OBSTRUCTIVE UROLITHIASIS IN RUMINANTS

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**Chattogram - 4225, Bangladesh**

**JUNE 2020**

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**Sreekanta Biswas**

**June, 2020**

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**This is to certify that we have examined the above Master's thesis and have found that is complete and satisfactory in all respects, and that all revisions required by the thesis examination committee have been made**

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# List of abbreviations

| Abbreviations | Elaboration |
|---|---|
| CVASU | Chattogram Veterinary and Animal Sciences University |
| SAQTVH | Shahedul Alam Quadery Teaching Veterinary Hospital |
| J&K | Jammu and Kashmir |
| CBC | Complete Blood Count |
| LDH | Lactate Dehydrogenase |
| AP | Alkaline Phosphatase |
| COD | Crystallography Open Database |
| MAP | Magnesium Ammonium Phosphate |
| UB | Urinary Bladder |
| PU | Perineal Urethrostomy |
| SD | Standard Deviation |
| SE | Standard Error |
| TEC | Total Erythrocyte Count |
| TLC | Total Leukocyte Count |
| Hb | Hemoglobin |
| PCV | Packed Cell Volume |
| ESR | Erythrocyte Sedimentation Rate |
| DLC | Differential Leukocyte Count |
| RBC | Red Blood Cell |

| | |
|---|---|
| WBC | White Blood Cell |
| TP | Total Protein |
| BUN | Blood Urea Nitrogen |
| CK | Creatinine Kinase |
| Na | Sodium |
| K | Potassium |
| Cl | Chlorine |
| Ca | Calcium |
| P | Phosphorus |
| mcl | Microliter |
| IU | International Unit |
| > | Greater than |
| < | Lesser than |
| % | Percent |
| ↑ | Increase |
| ↓ | Decrease |
| et al | And others |

# Abstract

Obstructive urolithiasis is one of the most serious urinary tract disease of ruminants mainly occurs in male. This research was conducted in SAQ Teaching Veterinary Hospital, Chattogram Veterinary and Animal Sciences University, Chattogram during the period from January, 2019 to December, 2019 and was carried out on 22 clinical cases (17 goats and 5 calves). The aim of the research was to know the changes of clinical parameters of urolithiasis by hematobiochemical, radiographical and ultrasonographical approaches. All animals affected with obstructive urolithiasis were males where, intact 19 (86.4%) and castrated 3 (13.6%). Most noticeable changes were found in heart and respiration rates which were found higher than the normal ranges in all cases. Hematological values, viz. TEC, TLC, Hb, PCV in clinical cases of obstructive urolithiasis were within the normal range except DLC, where neutrophils were significantly high with lymphocytopenia. Blood urea nitrogen, creatinine, creatinine kinase, inorganic phosphorus values were significantly higher than the normal ranges, while chlorine was lower than the normal range on biochemical examination. Blood urea nitrogen, creatinine, creatinine kinase values were significantly higher in cases of ruptured urinary bladder; however, hyperglycemia was found in cases of intact urinary bladder found on comparative study. Urinalysis found the evidence of urinary cast and triple phosphate crystal under microscopic examination. Plain radiographic examination was not successful for the detection of uroliths in any cases. Contrast radiographic examination in one goat was found urethral rupture near to the urethral diverticulum. Additionally, positive contrast normograde cystourethrography was used to detect urethral filling defect from urolithiasis in another goat. Hydronephrosis and perirenal fluid accumulation were diagnosed by ultrasonographic examination. Huge amount of stones were swirling inside the urinary bladder in all intact cases that were easily confirmed by ultrasonography. This study established that clinical parameters, laboratory findings, radiographical and ultrasonographical examinations are sufficient to diagnose effectively the obstructive urolithiasis in ruminants.



**Keywords:** Urolithiasis, ruminants, radiography, ultrasonography, diagnosis.

# Chapter - 1: Introduction

Obstructive urolithiasis is a very usual and prime hassle of urinary tract disease in ruminants. Male ruminants are mainly affected because of their peculiar anatomy which includes long, narrow, curved urethra and due to thin urethral process (Videla and van Amstel, 2016). Obstruction in the urethra in case of females is not usually occur due to the short length and malleable urethra (Mahajan et al., 2017). Urolithiasis describes the concretion of urinary calculi or organic compound, which may lodge anywhere in the urinary system but most frequently at the distal end of the sigmoid flexure in ruminants and causes subsequent urine flow obstruction (Tamilmahan et al., 2014). Testosterone deficiency in early stage causes penile hypoplasia, thus decreasing the bore size of urethra and failure of urethral process maturity. The age, types of feed and water, season and castration have been identified as predisposing factors in occurrence of the disease (Singh et al., 2008). The calculi are mostly found in urinary bladder, but can also occur in renal pelvis and urethra (Mohamed and Oikawa, 2008). The calculi dislodged from bladder may get trapped in narrow male urethra, sigmoid flexure or at preputial opening (Parrah et al., 2011). Urinary obstruction may also occur due to cystitis, which is a common problem encountered in male sheep, goat and cattle (Gugjoo et al., 2013).

The fundamental clinical signs comprised of anorexia, cessation of rumination, reduced intake of water, painful urination, bilateral abdominal distension, tenesmus, colic and grinding of teeth (Constable et al., 2017). Complete cessation of urethra can cause rupture of the urinary bladder or urethra within 24-48 hours (Smith and Sherman, 2009). Animals with complete urethral blockage exhibit tenesmus, tail movement, inappetence, bloat, depression and rectal prolapse may also be seen. Besides the clinical, physical and hematobiochemical examination, imaging technique like plain and contrast radiography are generally used in assessing the urinary tract lesions in ruminants (Loretti et al., 2003; Misk and Semieka, 2003). Radiography is not consistently successful to diagnose urolithiasis in cattle; however, ultrasonography can be efficaciously useful to diagnose urine retention due to obstructive urolithiasis in ruminants (Magda, 2006).

The available literature regarding hemato-biochemical alterations during the phase of urolithiasis are progressive. Moderate increment of Hb, PCV, and TEC values were found in confirmed instances of urolithiasis. A significantly higher neutrophil counts (56.64%) in confirmed cases of urolithiasis as compared to wholesome and suspected groups (37.75-43.84%) and decrease lymphocyte counts in confirmed instances indicated neutrophilia and lymphocytopenia in animals that succumbed to death because of urolithiasis (VinodhKumar et al., 2010). Urolithiasis affected cattle also have the same serum abnormalities except potassium and phosphorus incremented or within normal values with metabolic alkalosis (Sockett et al., 1986). Urolithiasis affected goats additionally have pronounced serum abnormalities most effective with azotemia (May et al., 1998). Azotemia is the only well-documented serum biochemical abnormality in urolithic goats (Van Metre et al., 1996).

Urinalysis can be a screening and diagnostic tool because of easy detection of substances or cellular materials in urine related to extraordinary metabolic and kidney disorders. The composition of urinary stones varies with geographical location. The basic mineral compositions of urinary calculi are generally varies in distinctive animals (Basiri et al., 2008). Silica urolithiasis usually occurs within the western United states in animals because of consuming feeds harvested from pastures with excessive silicate concentrations (Jones et al., 2009). Struvite urolith occur due to huge grain feeding and low dietary calcium to phosphorus ration (Makhdoomi and Gazi, 2013). A substantial factor in the availability of urolith components and their binding ability is urine pH (Van Metre, 2009); however, it may have little or no effect on silicate or calcium oxalate urolith.

Plain radiography reportedly a poor method to evaluate the urolith anywhere within the urinary tract without contrast study (Palmer et al., 1998). Radiography enables in differentiating among different varieties of urolith as their ratio densities provide a clue to the stone type (Kannan and Lawrence, 2010). Contrast radiography such as retrograde urethrography, cystourethrography, excretory urography, normograde cystourethrography through tube cystostomy has commonly been used for evaluation of obstructive urolithiasis. Sometimes rumen and abdominal viscera may cause difficulties to understand the urinary tract in plain radiographs (Singh et al., 1983).

Ultrasonography is very useful to obtain data from healthy animals and established the standards of renal measurements including length, height and width (Jarretta et al., 2004). Sonography can pick out stones positioned in the calices, pelvis, and pyelo- ureteric and vesicoureteric junctions, also as upper urinary tract dilatation. For stones >5 mm, ultrasound functions a sensitivity of 96% and specificity of nearly 100%. For all stones location, sensitivity and specificity of ultrasound reduces to 78% and 31%, respectively (Basiri et al., 2008). Sonography can detect small calculi, radiolucent calculi and bladder mass like polyp's neoplasia, stones of 1 to 2 mm of diameter that cannot be visible on X-ray, structures of varying size 1.50 to 2.7 cm floating in anechoic fluid (urine) within the urinary bladder with strong distal acoustic shadow are frequently detected. Scanning of bladder revels rounded to inconsistently hyperechoic shadows with more than one spread tiny hyperechoic patterns (Makhdoomi and Shiekh, 2008). In large animal practice, ultrasonography may be a valuable, applicable noninvasive diagnostic imaging technique for diagnosis of various surgical affections (Kotb et al., 2014). While ultrasound has been utilized sufficiently to determine fetal numbers and gestational age it could additionally yield essential clinical records within the chest, bladder, liver and kidneys (Scott, 2013). Ultrasonography has grown to be increasingly essential for physiological and clinical examination of the kidneys. It potentiates the clinical examination and clinicopathological analysis via supplying additional data on renal diseases (Floeck, 2007). Many renal disorders are associated with modifications in kidney length; therefore, in patients with chronic problems, such as recurrent urinary tract infection, vesicoureteric reflux, or a neurogenic bladder, renal growth is monitored. Renal size is the most usually used quantitative measure of renal size assessment with installed requirements (Kadioglu, 2010). To evaluate abnormalities in renal size, knowledge of standardized values for ordinary renal dimensions is essential because it indicates variability within the values of normal renal size (Raza et al., 2011). Ultrasonography of the kidneys enables to detect modification in size, location and pathological situation together with hydronephrosis, nephritis and renal tumors (Vosough and Mozaffari, 2009). It is likewise used to manual strategies including fine-needle biopsy, percutaneous pyelocentesis, and antegrade pyelography. Despite its vital rule in diagnosis, it has several limitations because it is operator dependent; also provide a limited assessment of renal function not like computed tomography (CT) or intravenous pyelography (Noble and Brown, 2004). In sheep and goats ultrasonographic scanning may be beneficial for the prognosis and diagnosis of this disease (Makhdoomi and Gazi, 2013).

However, to the best of my knowledge very limited work has been done in our country regarding the specific diagnostic evaluation for obstructive urolithiasis in ruminants. The result from this current study could help to diagnose obstructive urolithiasis in ruminants specifically by using some diagnostic tools. So, the present study was conducted to know the changes of clinical parameters, blood, serum, urine and anatomical structure of urinary tract during urolithiasis by hematobiochemical, radiographical and ultrasonographical approaches.

# Chapter - 2: Review of Literature

Urolithiasis is a common ailment of male ruminants such as cattle, sheep and goats (Janke et al., 2009). It is the most frequent reason of urinary tract disorder in small ruminants (Haven et al., 1993) and although generally sporadic, can result in considerable losses in production livestock, exhibition animals, and pets. Urinary tract obstruction is the most common place in castrated males (Constable et al., 2017) and the most customarily entails the urethra. Urolith formation in ruminants is probable multifactorial and may be encouraged by control practices and diet (Stratton-Phelps and House, 2004).

## 2.1. Incidence

Although the prevalence of obstructive urolithiasis is commonly sporadic, outbreaks affecting a large wide variety of animals had been additionally recorded (Constable et al., 2017). A universal occurrence of 5.04% in animals has been said in India. The species wise prevalence has been stated as: goats 49.83%, cattle 32.87%, dogs 14.53%, horses 1.38%, sheep 1.04% and cats 0.34% (Amarpal et al., 2004). A study conducted on 2322 instances of bovine urolithiasis discovered 98.62% prevalence in castrated males, 0.99% in bull calves, 0.13% in buffalo calves, 0.086% in cows and in keeping with 0.04% in buffalo bulls (Bhatt et al., 1973). From the Kashmir valley of J&K nation an usual prevalence of 12% in cases of obstructive urolithiasis in cattle has been reported (Sheikh et al., 2018). A higher incidence of obstructive urolithiasis in cattle and sheep has been reported abroad (Tiruneh, 2000). An incidence of 12.65% in cattle of Belgium (Gasthuys et al., 1993), 1.2% in Japanese black cattle, 0.34% in Holsteins (Tsuchiya and Sato, 1988), and 37.14% in cattle and 44.93% in sheep of Ethiopia (Tiruneh, 2000) has been said. An incidence of 0.5% and 0.35% of urolithiasis for 2 Colorado lamb feedlots in America is reported (Salman et al., 1988).

### 2.1.1. Geographical distribution

Urolithiasis has been suggested from all corners of the world. In India prevalence of urolithiasis is very high in the states of Punjab, Haryana, Utter Pradesh, Bihar, Madhya Pradesh, Orissa, Andhra Pradesh, Tamilnadu, and Jammu and Kashmir (Gugjoo et al., 2013). Globally, disease has a usual occurrence in North American countries, United

Kingdom, Australia, Switzerland, Scotland, Japan and Africa (Tiruneh, 2000). Apart from India, this condition is not very unusual in north American countries, United Kingdom, Australia, Switzerland, Scotland and Japan (Bailey, 1981).

### 2.1.2. Age

Urolithiasis affects all ages of animals, but is more prevalent in bovines below two years of age due to feeding of high proteinaceous diet and changes brought about by weaning (Bhatt et al., 1973). A high incidence of urolithiasis has been reported in caprine (69.44%) and bovine (60%) below 6 months of age (Amarpal et al., 2004). Eighty nine per cent cases of bovine urolithiasis have been reported between the ages of 2 to 6 months (Fazili and Ansari, 2007). Most of the animals suffering from urolithiasis in Sweden were 3 to 4 months old (Gasthuys et al., 1993).

### 2.1.3. Sex and breed

Urolithiasis appears to affect equally each sexes, however urinary blockade is a critical problem only in males. Males are mostly tormented by obstructive form of the disease due to anatomical conformation of their urinary tract, that is lengthy and tortuous (Constable et al., 2017). High incidence of urolithiasis is determined in those animals that are castrated in early life (Singh et al., 2005). No breed of cattle among those of European origin seems greater prone than every other to the formation of calculi (Bailey, 1981). However genetic predisposition in the formation of urolith cannot be dominated out totally. Cross breed Jersey cattle are more affected than nearby non-descript in Kashmir Valley of J&K state (Fazili and Ansari, 2007). Likewise Japanese black cattle are greater inclined than Holsteins (Tsuchiya and Sato, 1988). Dwarf African breeds of goats are greater at risk of urolithiasis than other breeds (George et al., 2007). The Saanen breeds of goat commonly excrete high degrees of phosphorus in urine.

### 2.1.4. Season

Season seems to have a profound impact on the improvement of urolithiasis in animals. An excessive incidence of urolithiasis discovered during wintry weather months is concept to be due to decrease water consumption, deficiency of vitamin A and to the feeding of excessive concentrates (Sheikh et al., 2018). Feeding of concentrates at common intervals in some stages of winter months induces antidiuretic hormone release, which reasons a marked however temporary decline in urine output and an increase in urine concentration (Bailey, 1981). The high prevalence within the spring and summer season, with most seen from April to September as compared with winter seen from October to March in small ruminants (Ewoldt et al., 2006). However, vitamin A supplementation does not seem to have any effect at the prevalence of urolithiasis in Chinese Swamp buffaloes (Huang et al., 1999). Higher prevalence of urolithiasis in ovine and caprine happens throughout severe wintry weather and summer time (Amarpal et al., 2004). The high occurrences of urinary calculosis all through the summer is attributed to increase in crystallization of urine because of perspiration and dehydration (Bhatt et al., 1973).

### 2.1.5. Composition of urolith

The composition of urinary stones varies with geographical location. The primary mineral compositions of urinary calculi are generally varies in different animals (Basiri et al., 2008). Silica, magnesium ammonium phosphate (struvite), calcium carbonate and calcium oxalate are the common kinds of crystals found in ruminants. Silica urolithiasis normally occurs in the Western United States in animals, which can be grazing pastures or consuming feeds harvested from pastures with excessive silicate concentrations (Jones et al., 2009). Struvite uroliths form when urine grow to be supersaturated with magnesium, ammonium or phosphorus and whilst urine pH>6 (Straub et al., 2005). Calcium oxalate uroliths are often found in goats managed on diet, rich in calcium and oxalic acid (Clark et al., 1999). Struvite, apatite and urate uroliths are discovered more often than not in bitches, oxalate, cystine, silica and brushite are notably extra regularly occurring in males.

### 2.1.6. Location of calculi

Length of the urethra, presence of sigmoid flexure and urethral process make the urethra more vulnerable to the lodgment of calculi as compared to other parts of the urinary tract in ruminants. Bovine urinary calculi are usually of irregular size and diameter and are mostly determined at the insertion of retractor penis muscle in the distal sigmoid flexure. In sheep, the urethral process is the most typical site of urethral obstruction by urolith. The diameter of urethral lumen on the sites of distal sigmoid flexure and urethral process are the narrowest, consequently calculi could without problems be trapped at these sites (Tiruneh, 2000). The commonest sites for obstruction of the canine urethra by uroliths are the caudal os-penis and the ischial arch, in that order. However, most dogs with urethral calculi do have vesicle stones also (Holt, 1997). Calculus in canines can also be present along the whole length of urethra (Thilagar and Balasubramanian, 1996).

### 2.2. Aetiopathogenesis of urolithiasis

#### 2.2.1. Predisposing factors

Major predisposing factors prone to urolith formation include: increased urinary salt concentration, decreases in urinary protective colloids, urinary tract inflammation, hypovitaminosis A, hypervitaminosis D, reduced water intake, increased insensible water losses, sulphonamide precipitation in urine, changes in urine pH, castration of bulls (decreases urinary colloids e.g. hyaluronidase) (Gutierrez et al., 2000). Cereal grain and oil meals have high degrees of phosphorus and magnesium however noticeably low level of calcium and potassium predispose to disease condition (Constable et al., 2017) Other predisposing factors listed include: age, sex, skin texture, genetic make-up, hormonal imbalances, soil, season, lactation, hydrophilic colloids, composition of feed and water, availability of vitamins and minerals, infection, stress and water hardness (Bhatt et al., 1973). Actually it is not the best single factor but interaction of so many factors which results in the formation of urolith in any species. Solute load, ionic strength complexation and pH impact the availability of the crystalline components (Smith, 1989).

#### 2.2.2. Water intake and its hardness

Reducing water consumption could cause relative increase in urinary mineral solutes concentration and their precipitation. Therefore, the animals that drink excess will excrete more diluted urine, in order to generally tend to reduce the probability of calculi formation (Tiruneh, 2000). Increased fluid intake decreases the threat of calcium stone formation by lowering the contact time of crystalline material with potentially adsorptive nephron surfaces and diluting a number of the promoters of crystallization (Pak et al., 1980). Drinking of soft water favors conditions for the formation of oxalate stones than drinking of hard water (Caudarella et al., 1998). Total calcium consumption is greater crucial than the extent of calcium in water for the prevalence of calcium oxalate urolithiasis (Da Silva et al., 1994). High water hardness (mean 285 ppm) with high magnesium ion concentrations in water results urolithiasis in 20.4% of cattle (Sahinduran et al., 2007).

### 2.2.3. Urine pH

The pH of urine greatly affects on the formation of types of calculi, generally mixed phosphate and carbonate calculi easily formed on alkaline urine than acidic urine. The rich urine potassium concentration in herbivores also plays an important role to have an alkaline urine (Constable et al., 2017) Urine pH plays a prime role in precipitation of salts in urinary tract. Struvite uroliths form at a urine pH range of 7.2 to 8.8, whereas calcium phosphate uroliths form at a urine pH range of 6.5 to 7.5 (Elliot et al., 1958). Increases in urine pH favor precipitation of phosphate calculi in goats (Smith and Sherman, 2009).

### 2.2.4. Dietary composition

Dietary composition impacts electrolyte balance and finally urine pH, ion aggregation and crystal formation are depending on the pH of the solution and the concentration of ions within the urine (Stratton-Phelps and House, 2004). Calcium, phosphorus and magnesium levels in the diet, serum and urine are integral in the formation of magnesium ammonium phosphate (struvite), calcium phosphate and calcium carbonate uroliths in cattle, sheep and goats. Calculi can be induced by feeding excessive phosphorus diets and the animals will have excessive serum and urinary phosphorus concentrations. High urinary phosphorus is found to be directly correlated with occurrence of urinary calculi. By increasing dietary phosphorus, urinary and serum phosphorus increases (Godwin and Williams, 1982).

### 2.2.5. Urinary tract infection (UTI)

Nidus is the additional factors for the formation of calculi in goats. Desquamated epithelial cells act as a nidus in the urinary bladder, which may be resulting from vitamin A deficiency and infections of the urinary tract (Smith and Sherman, 2009). In human patients, proteus contamination results in struvite urolithiasis even as E. coli contamination will increases the probabilities of formation of struvite and calcium phosphate calculi (Holmgren et al., 1989).

### 2.2.6. Phytoestrogens

Exogenous estrogens either in the diet or from growth-promoting implants can also lead to reduced urethral diameter by promoting swelling of the surrounding accessory sex glands in the pelvic region (Smith and Sherman, 2009). In ruminants, plants containing oxalate and phytoestrogen are often responsible for the formation of uroliths. Administration of estrogen is the cause of excessive epithelial desquamation which tends to urolith formation (Constable et al., 2017).

### 2.3. Diagnostic procedures

Diagnosis based on history, clinical signs, and physical examination is usually straightforward. However, urinalysis, urine culture, radiography and ultrasonography may be required to differentiate patients with uroliths from those with urinary tract infection, neoplasia, polyps, granulomatous urethritis, prostatic disease and blood clots (Makhdoomi and Gazi, 2013)

#### 2.3.1. Clinical observations

Obstruction of the urethra, by means of a calculus early on, reasons a characteristic syndrome of abdominal pain manifested with the aid of kicking at the belly, repeatedly lying down and rising, rolling, falling and moaning, swishing of the tail, twisting of the penis, strenuous efforts to urinate, treading with rear limbs (Singh et al., 2005). Animals with chronic partial urethral obstruction are termed as, “dribblers” due to their characteristic slow or intermittent urine flow at some point of voiding (Constable et al., 2017). If block persists either urethra or bladder will rupture, usually within 48 hours. In case of urethral rupture urine escapes into the tissues surrounding penis and edematous type of swelling occurs on abdominal floor (Singh et al., 2005). Subcutaneous infiltration of the urine results in necrosis within the area involved. Severely affected cattle develop dilation of the urethra proximal to the obstruction that’s manifested as a visible swelling localized to the midline of the perineum (Gasthuys et al., 1993). Dullness, anorexia, restlessness, constipation, tympany, uremic odor from mouth, tough coat and erect hair, anemia, swollen face, pressing of head in terminal stages are other essential clinical observations found in obstructive urolithiasis (Pandey and Singh, 1989). Respiration and heart rate may increase (Joshi et al., 1989). Observations concerning rectal temperature may be relatively variable. It may also continue to be unchanged (Gangwar et al., 1990), decrease (Joshi et al., 1989) or increase (Jones et al., 1996). Probably the stage of uremia is more important determinant for rectal temperature than the time of presentation of animal. Rumen motility generally decreases (Gangwar et al., 1990).

### 2.3.2. Laboratory examination

#### 2.3.2.1. Hematological alterations

The increasing value of each animal coupled with advanced owner knowledge and expectations has resulted in the CBC turning into an essential device in the management of ruminant medical cases (Jones and Allison, 2007). A high value of hemoglobin, hematocrit, total leucocytes and neutrophils occurs in bullocks suffering from urine retention due to urolithiasis (Gera and Nigam, 1981). More profound alterations in hematological parameters are recorded in obstructive urolithiasis instances with ruptured bladder. Total erythrocyte count, hemoglobin and PCV values returned to pre-operative levels within 72 hours post treatment with peritoneal and pleural dialysis in all groups of animals (total 18 goats) affected by experimentally induced uremia (Reddy et al., 1995).

#### 2.3.2.2. Biochemical alterations

Increase in blood urea nitrogen and creatinine (Villar et al., 2003) happens in instances of obstructive urolithiasis. However, no correlation exists between the BUN and the severity of uremia; however, the recovery is associated with a fall in BUN and restoration of electrolyte balance (Sharma et al., 1981). The increase in creatinine has more diagnostic significance than BUN, specifically in terminal stages of uremia in goats (Pandey and Singh, 1989). Leakage of urine into the subcutaneous space due to urethral rupture produces similar; however, much less severe serum biochemical alterations than those with bladder rupture (Donecker and Bellamy, 1982). Hyponatremia may also or won't arise in instances with post renal azotemia (Sharma, 2012). Hyponatremia may additionally develop due to loss of fluids and electrolytes (Sharma, 2012). The variability in the degree of improvement of hyponatremia or unaffected plasma values might also occurs relying upon the capability of the animal to regulate sodium concentration through alternate routes. Hyperkalemia following retention of urine in cattle is a common finding. However, adjustments via saliva in ruminants do not permit the development of hyperkalemia of a higher order. If the adjustment takes place by excreting huge amounts through saliva, the plasma concentration may stay normal (Sockett et al., 1986). The increased loss of potassium through the saliva takes place due to secretion of aldosterone in response to hyponatremia. Both unaffected plasma calcium values (Singh *et al.*, 1984), and hypocalcaemia (Sockett et al., 1986) following retention of urine in cattle has been reported. Absorption of calcium is affected by calcium phosphorus ratio within the gut and an increase in phosphorus will reduce absorption of calcium (Sharma, 2012). Possible tissue hypoxia due to disorders following retained urine with breakdown of high energy phosphate compounds may cause hyperphosphatemia (Sharma, 2012). Similarly observed hyponatremia, hypochloremia and hyperphosphatemia in cattle subjected to experimentally induced rupture of the urinary bladder (Donecker and Bellamy, 1982). Higher mean BUN, creatinine, lower mean phosphorus, and sodium concentration with no difference in mean calcium concentration in the serum of goats suffering from urolithiasis (George et al., 2007). Hyperoxalemia in chronic renal failure produces saturation of the blood with respect to calcium oxalate monohydrate, and consequently is chargeable for the deposition of calcium oxalate crystals in kidney, myocardium, blood vessels and other tissues in sufferers with uremia (Worcester et al., 1986).

### 2.3.3. Urinalysis

Laboratory examinations may be useful in the diagnosis of urolithiasis in its early stages when the calculi are present in the kidney or bladder (Constable et al., 2017). Urinalysis is a simple, non-invasive and cheap laboratory test that rapidly provides valuable information about the urinary tract and other body systems.

#### 2.3.3.1. Physical examination of urine

Observing the color, transparency, microscopic and chemical characteristics of urine and urinary sediment along with microbial way of life and sensitivity test is likely to identify the maximum number of lower urinary tract disorders in domestic animals. The color and transparency of urine is recorded even as watching it in a test tube or urinometer cylinder. The color is always considered in affiliation with specific gravity and volume. The ordinary color is yellow to light amber in cattle and depends primarily on the concentration of urochromes, whose output is relatively constant (Benjamin, 1978). The urine may be light to dark yellow and pale pink in color in bovine stricken by urolithiasis. In bovine obstructive urolithiasis urine may be transparent and cloudy (Braun et al., 2006). Specific gravity in health varies with the state of hydration and fluid intake. The range of specific gravity of urine in normal cattle is 1.025-1.045 with an average of 1.035 (Benjamin, 1978), and in obstructive urolithiasis it could be, 1.008 to 1.025 (Braun et al., 2006).

#### 2.3.3.2. Chemical analysis of urine

Chemical analysis of urine can be reflected in the composition of the calculi (Neumann et al., 1994).

##### 2.3.3.2.1. Urinary pH

An accurate measurement of urine pH is essential for clinical choice making mainly in urolithiasis cases, and is typically made with a pH meter (Raskin et al., 2002). However, acidic urine is not also unusual finding (Braun et al., 2006). Urine pH plays a vital role in the formation of uroliths. Struvite and calcium apatite uroliths are mostly found in alkaline pH (Singh et al., 2005), whilst cystine stones are formed at the acid pH. However pH is variable in the formation of urate, silicate and calcium oxalate stones (Lulich and Osborne, 1992).

##### 2.3.3.2.2. Urinary proteins

The estimation of urinary protein will be an illustration of predisposing factors for urolithiasis as about two third of the matrix of all urinary stones is constituted by using proteins (Grover and Resnick, 1995). A small amount of protein may be normal. Proteinuria may result from glomerulonephropathy, tubular transport defects, or inflammation or infection within the urinary tract. Hemorrhage ought to be marked (macroscopic rather than microscopic) before it causes significant proteinuria (Vaden et al., 2004).

##### 2.3.3.2.3. Inorganic constituents of urine

Certain physiological relationships do exist many of dietary intakes of certain minerals and their corresponding levels in the urine and the possibility of urolithiasis (Robbins et al., 1965). Animals having greater excretion of phosphorus in their urine will be more prone to the formation of insoluble phosphates and urinary calculi (Cuddeford, 1987). Urinary excretion of phosphorus has genetic basis, as few breeds of sheep like Texel and Scottish blackface excrete greater phosphorus in urine in comparison to other breeds, and are hence more susceptible to phosphate urolithiasis (Field, 1969). However, lambs fed on high phosphorus, low calcium diets had increased concentration of phosphate in urine, which was related to a vast lower in urinary excretion of magnesium and potassium and increased the incidence of urolithiasis (Robbins et al., 1965).

#### 2.3.3.2.4. Enzymes

Injury caused by oxalate crystals to the renal epithelial cells may cause increase in the level of various enzymes like LDH, α-Glutamyltranspeptidase, AP, Inorganic pyrophosphates, β-glucuronidase, λ-acetyl γ-D glucuronidase and lipid peroxidase (Lenin et al., 2001).

### 2.3.3.3. Microscopic examination of urine

The microscopic examination of urine has great clinical importance. The important materials to recognize including crystals, erythrocytes, leukocytes, casts and bacteria (Benjamin, 1978). Supravital staining technique, using 1% crystal violet and 0.5% safranin in normal saline is deliberated good for analyzing urine sediments under general bright field microscopy (Dinda et al., 2000).

#### 2.3.3.3.1. Crystalluria

Crystalluria is a frequent finding in the routine examination of urine sediment. Crystalluria can also be due to drugs such as sulphadiazine (Fogazzi, 1996). Struvite crystals have coffin lid appearance; calcium oxalate monohydrate crystals have picket fence appearance, envelope ditetragonal pyramids/bipyramidal form, at the same time as calcium oxalate dihydrate crystals have a Maltese cross or rectangular envelope form (Singh et al., 2005). The urine of a goat fed on a diet containing calcium and oxalic acid was found to contain numerous cuboidal bipyramidal; and precise rectangular parallel piped COD crystals (Clark et al., 1999). Planar or X-shaped morphology of struvite crystals indicate rapid growth while misshapen or octahedral shape shows slowed growth rate (McLean et al., 1991).

#### 2.3.3.3.2. Cellular components

A specific number of epithelial and transitional cells in urine are normal. Transitional cells are elevated in cystitis and pyelonephritis. Likewise, few leukocytes may be present in normal urine. Pyuria indicates a purulent process at some point in the urinary tract especially urethritis or cystitis (Benjamin, 1978).

### 2.3.4. Diagnostic imaging

Apart from history, clinical signs and physical examination of the urolithiasis cases radiology and ultrasonography may be required to differentiate patients with uroliths from urinary tract infections, granulomatous urethritis, prostatic disease and neoplasia (Makhdoomi and Gazi, 2013).

#### 2.3.4.1. Radiography

In regions in which radiopaque calculi (calcium carbonate, calcium oxalate, silica) are normally encountered in small ruminants, plain radiographs are endorsed to decide the right surgical method and to confirm resolution of the obstruction (Kinsley et al., 2013). Radiopaque uroliths including struvite and calcium oxalate calculi may be seen on plain radiographs, however contrast studies have been recommended for reliable radiological diagnosis of obstructive urolithiasis (Palmer et al., 1998). Most of the uroliths larger than 3 mm could be detected by means of survey abdominal radiography or ultrasonography. For smaller uroliths double contrast cystography or urethrography is used (Johnston et al., 1986). These techniques in small ruminants and swine are infrequently used because of the problems in catheterization of the male urethra (Timm and Watrous, 1988). Double contrast cystography is a useful method for the assessment of the bladder wall (Palmer et al., 1998), as it provides maximum visualization of mucosal and serosal surfaces of the bladder wall (Tayal et al., 1984). Normograde contrast cystourethrography through a tube cystostomy catheter is useful for evaluating the extent of urethral obstruction or urethral integrity postoperatively and therefore is potentially used to monitor urethral healing, assess medical therapy for calculi dissolution, and determine when the animal must be encouraged to micturate through the urethra by means of occluding the drainage catheter (Palmer et al., 1998). Non contrast helical computerized tomography is being used increasingly in the initial assessment of renal colic (Smith et al., 1999).

#### 2.3.4.2. Ultrasonography

Real-time transabdominal B-mode ultrasonography frequently used to evaluate the bladder, kidney, urethra and stomach cavity. In suspected urolithiasis cases, ultrasonography is cautioned to verify the presence of dilated bladder and to determine whether or not uroperitoneum is present (Braun et al., 1992). Ultrasonography can be useful in detecting the urolith location (penis, bladder, ureter and kidney), rupture of the urogenital tract, and the presence of the uroperitoneum and hydronephrosis (Seco diaz et al., 2004). Accumulation of uroliths within the bladder may appear as a focal hyperechoic zone, with an outstanding acoustic shadow originating from the mucosal surface. The kidneys of animals tormented by urolithiasis ought to be tested for proof of nephrolithiasis or hydronephrosis, the presence of either justifies a poorer prognosis. Uroperitoneum is clear as anechoic fluid accumulation in the dependent portion of the abdomen. A defect in the bladder wall can once in a while be visualized ultrasonographically. However, uroperitoneum is regularly associated with pinpoint leaks in small ruminants, instead of overt bladder rupture (Ewoldt et al., 2006). Ultrasonography cannot be performed along with pneumocystography or double contrast cystography because sound waves would be completely reflected. However it may be finished together with excretory urography or positive contrast retrograde urethrocystography to provide the information about filling defects within the kidney or urinary bladder (Johnston et al., 1986).

#### 2.3.4.3. Urethral endoscopy

Urethral endoscopy has been found useful in evaluating urethral patency, examining urethral mucosa following relief of urethral obstruction to assess the long term prognosis for urethral strictures and helping in conducting laser lithotripsy for the management of urolithiasis by providing a route (Halland et al., 2002).

## 2.4. Managemental procedures

The primary treatment for obstructive urolithiasis though is surgical (Van Metre et al., 1996), but the cases at their early stages especially with incomplete obstruction, called dribblers, could be managed by therapeutical (medical) regimens.

### 2.4.1. Medical (Therapeutic) management

#### 2.4.1.1. Allopathic therapy

Smooth muscle relaxants act via beginning of voltage dependent potassium channels and therefore supporting to get rid of calculi (Achar et al., 2003). The medical treatment of urolithiasis with intravenous fluids, non-steroidal anti-inflammatory agents or tranquilizers is pronounced with much less success (Rakestraw et al., 1995). It has been demonstrated to reduce the occurrence of MAP calculi in high magnesium and phosphate diets in goats

(Senthilkumar et al., 2001a). Dietary ammonium chloride supplementation at a dose of 450 mg/kg may be essential to attain the urine pH <6.5 in goats (Mavangira et al., 2010). Though ammonium chlorides can decrease the occurrence of urolithiasis in ruminants but having negative impact on diet intake at greater levels and sodium chlorides ineffective as an acidification agent, an anionic diet or supplement could be the solution, because anionic supplement increases urine volume and urine acidification (Stratton-Phelps and House, 2004). Cystocentesis via ultrasonography in combination with percutaneous infusion of Walpole's solution may be a satisfactory treatment in male goats with obstructive urolithiaisis (Janke et al., 2009).

#### 2.4.1.2. Homeopathic therapy

The marketed composite herbal formulations, Cystone (Himalaya Drug Company, India), Calcuri (Charak Pharmaceuticals, Bombay India) and Chandraprabha bati (Baidyanath, India) are extensively used clinically to dissolve urinary calculi within the kidney and urinary bladder (KVSRG et al., 2007). Horse gram (Dolichos biflorus) has been observed to have tendency to prevent the occurrence of urinary calculi in goats (Senthilkumar et al., 2001b).

### 2.4.2. Surgical management

Treatment of obstructive urolithiasis is primarily surgical (Van Metre et al., 1996). Various surgical techniques employed for achieving these goals include:

#### 2.4.2.1. Urethrotomy

Urethrotomy, either post scrotal or post-ischial at the site of calculi lodgement is widely encouraged and practiced to alleviate the obstruction (Makhdoomi and Shiekh, 2008). The different procedures for urethrotomy in bulls include, ischial urethrotomy (Streeter et al., 2001), infra-anal urethrotomy (Ravikumar and Shridhar, 2003). A technique over the distal sigmoid flexure incorporates the best chance of being located directly over the calculus. Ischial urethrotomy provides rapid get right of entry to the bladder for catheterization and to the obstructing urolith for lithotripsy in steers (Streeter et al., 2001).

#### 2.4.2.2. Perineal urethrostomy

Perineal urethrostomy (PU) can provide effective long-term period resolution of obstructive urolithiasis in goats (Oman et al., 2019). Transection of penile body attachments from the pelvis and careful mucocutaneous apposition may decrease the danger of postoperative urethral stricture formation in goats after PU (Tobias and van Amstel, 2013). PU is considered a salvage technique, because stricture and recurrence of signs and symptoms occurs in 45-78% of goats within 8 months after surgery (Haven et al., 1993).

#### 2.4.2.3. Urethral catheterization and flushing

Successful retrograde urethral catheterization and saline flushing (termed urohydropulsion) is helpful for relieving urethral obstruction in cats and dogs. However, this procedure does not appear to be successful in most cases in small ruminants; only 1 of 35 small ruminants treated at admission with urohydropulsion became unblocked (Van Metre and Smith, 1991).

#### 2.4.2.4. Urethral process amputation

Urethral process amputation can be expected to restore urine outflow in approximately one half of small ruminant urolithiasis cases, according to data from two reports (Van Metre and Smith, 1991; Haven et al., 1993). Failure to restore urine outflow after amputation indicates the presence of additional calculi in the lower urinary tract, frequently located in the area of the sigmoid flexure and bladder.

#### 2.4.2.5. Penectomy (Penile Amputation)

Penectomy is considered a salvage procedure for intact and castrated ruminants and swine intended for slaughter (Fubini and Ducharme, 2017).

#### 2.4.2.6. Cystotomy and cystorrhaphy

Surgical technique to the bladder is most typically on the ventral aspect of the bladder. The bladder incision is closed by using absorbable, single layer, appositional suture. Cystotomy must constantly accompany mucosal biopsy and must be observed with the aid of lateral radiographs to affirm the elimination of all the calculi (Cornell, 2000). In another study, 8 of 11 small ruminants were successfully handled with cystotomy and urethral hydropropulsion, but 5 of these animals experienced recurrent urethral obstruction at an average of 15 months after surgery (Van Metre et al., 1996).

#### 2.4.2.7. Laparoscopic cystotomy

Laparoscopic cystotomy is believed to decrease the cost of operation and hospitalization. Urinary calculi have been removed by laparoscopic assisted cystotomy in three dogs (Rawlings et al., 2003). Repair of ruptured urinary bladder has been performed in stallion (Walesby et al., 2002) and in foal (Rijkenhuizen et al., 2003). Laparoscopic-assisted cystotomy with catheter implantation was proved to be more suitable technique in male sheep for removal of uroliths in patients suffering from obstructive urolithiasis (Franz et al., 2009). Laparoscopic tube cystotomy proved a feasible techniques in rams and bucks rather than open conventional tube cystotomy in cases of urine retention syndrome (Gomaa et al., 2015).

#### 2.4.2.8. Tube cystostomy

Tube cystostomy with Foleys catheter turned into the most simple satisfactory method and inexpensive for the management of obstructive urolithiasis in small ruminants (Sutradhar et al., 2018). Foley's catheter may reduce the calculi size through bypassing urine and also clamping the Foley's catheter facilitate urethral patency by flushing urethra of all debris and calculus material (Ewoldt et al., 2006). The procedure is very simple, requiring a short duration of anesthesia and resulting in restoration of full urethral patency in successful cases (Fortier et al., 2004). Tube cystostomy was determined to be an easy and useful technique in the management of obstructive urolithiasis in small ruminants and buffalo calves with high success rate (Mahajan et al., 2017). Tube cystostomy, a urinary diversion or urethral bypass approach, has end up popular as a treatment for obstructive urolithiasis in small ruminants and buffalo calves with subsequent scientific dissolution of the urolith (Kushwaha et al., 2014). Surgical tube cystostomy and bladder marsupialization are both acceptable surgical methods for caprine obstructive urolithiasis (Fortier et al., 2004). Tube cystostomy may be a beneficial therapeutic option in the management of small ruminants with obstructive urolithiasis with concurrent rupture of the urethra, mainly for cases in which treatment cost is a limiting factor (Pearce et al., 2003).

### 2.4.2.9. Bladder marsupialization

Surgical tube cystostomy via Foley's catheter and bladder marsupialization are considered admissible surgical techniques for the management of caprine obstructive urolithiasis; however, percutaneous tube cystostomy should be avoided (Fortier et al., 2004). Bladder marsupialization is usually a single-procedure treatment, and therefore might be less expensive than tube cystostomy. Although the success rate for bladder marsupialization is reportedly relatively high (80%), all animals are affected by urine scald (May et al., 2002). In the face of, urine scald, 88% of owners said that the final outcome as satisfactory (May et al., 1998). Other complications including cystitis and bladder mucosal prolapse affected 25% of operated goats (May et al., 2002).

# Chapter - 3: Materials and Methods

## 3.1. Study area

The study was conducted at Shahedul Alam Quadery Teaching Veterinary Hospital (SAQTVH), Chattogram Veterinary and Animal Sciences University (CVASU), Chattogram, Bangladesh.

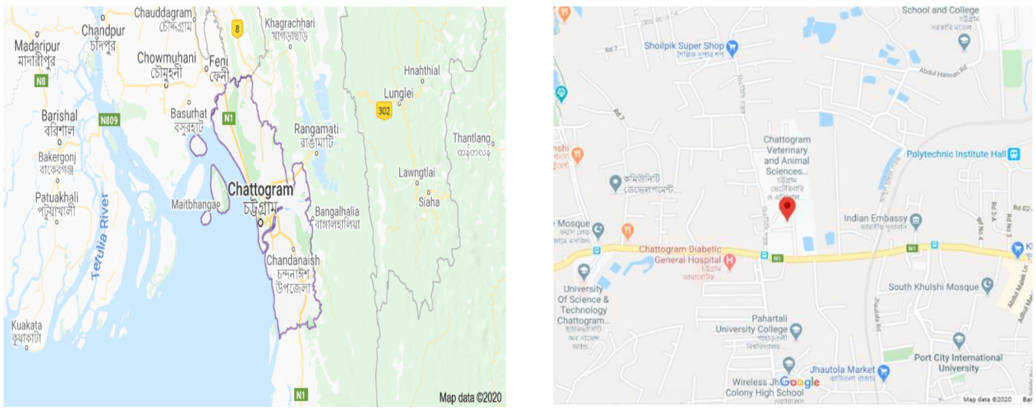


**Figure 3.1:** Geographical location of the study area on Google map

## 3.2. Criteria for case selection

The conducted study on clinical cases came to SAQTVH for the treatment of presumptive suspicion for urolithiaisis. Definition of case selection was history of complete retention of urine. The selection criterion was to select suspected cattle and goats coming for health care between January to December of 2019.

## 3.3. Study design

Seventeen male goats and five male bovine calves of different ages, suffering from complete retention of urine, presented for treatment at SAQTVH, formed the material of this study.

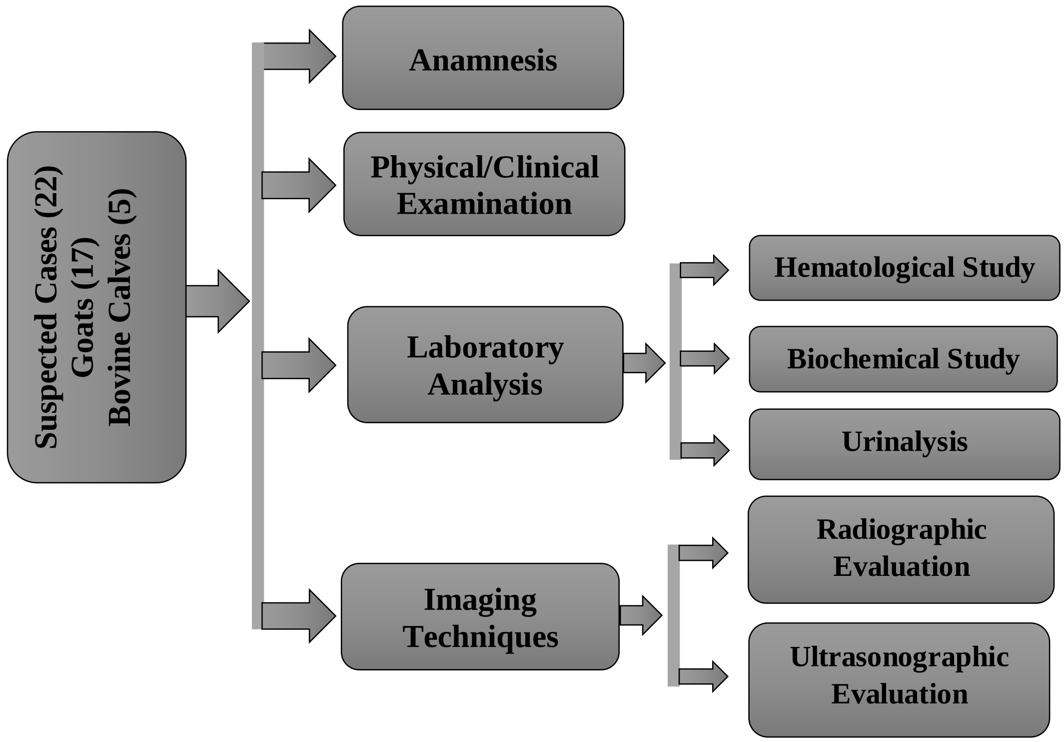


**Figure 3.2:** The overall study outline including number of experimental animals, physical & laboratory examinations and imaging were expressed on the block list

### 3.4. Data collection

#### 3.4.1. Medical history

A complete history of the age, breed and sex of the animal, castration status, duration of illness, managemental practices, feeding habits of the animal, early signs of the disease, previous treatment, if any, were recorded.

#### 3.4.2. Clinical examination

Heart rate (beats/min), respiration rate (breaths/min), rectal temperature (°F), skin fold test time (seconds), general body condition (alert/dull/depressed/other), dehydration (mild/moderate/severe), besides other clinical signs exhibited by the animals were recorded. Extent of dehydration percentage was estimated by skin fold test. Others specific observation included straining (absent/present) (**Figure 3.3**), distended abdomen (**Figure**

3.4), swelling of the penile sheath (**Figure 3.5**), abdominal ballottement primarily to check the urinary bladder whether it was intact or ruptured. Urethra was palpated manually to locate any calculi, if possible.

**Figure 3.3:** Forceful attempt to urinate showing postural defect (straining) of a goat suffering from urinary obstruction

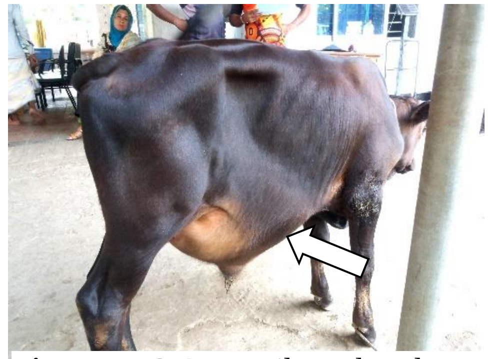

**Figure 3.4:** Bilateral lower abdominal distension (white solid arrow) of a male calf suffering from urinary obstruction

**Figure 3.5:** Swelling of penile sheath (white solid arrow) of a goat suffering from urinary obstruction

### 3.4.3. Laboratory analysis

#### 3.4.3.1. Hemato-biochemical study

For hematobiochemical study, 6 ml blood was collected from patients aseptically by jugular venipuncture (**Figure 3.6**). 2 ml blood sample was taken into an EDTA (Ethylene diamine tetra acetic acid) anticoagulant containing vacutainer for hematological study and the remaining 4 ml blood was taken into an anticoagulant free vacutainer and allowed to clot at room temperature within 3 hours of collection. The serum sample was stored at -

20°C for biochemical studies. Following hematological test TEC, TLC, Hb, PCV, ESR and DLC parameters were estimated by using standard techniques (Sastry, 1985). For biochemistry analysis (**Figure 3.7**) total protein, glucose, BUN, creatinine, creatinine kinase, Na, K, Cl, Ca, P values were estimated by using the commercially available kits and the readings were taken by using spectrophotometer.

**Figure 3.6:** Collection of blood sample via jugular venipuncture from a goat

**Figure 3.7:** Serological diagnostic test of blood samples to check the biochemical alterations

### 3.4.3.2. Urinalysis

For urinalysis about 100 ml of urine sample was collected aseptically through the Foley's catheter or urethral catheter during operating time and urine color, specific gravity (**Figure 3.8**), urine pH, glucose (**Figure 3.9**), protein and microscopic examination of uroliths were recorded.

**Figure 3.8:** Determination of specific gravity by urinometer method

**Figure 3.9:** Determination of presence or absence of glucose in urine by Benedict's test

### 3.4.4. Imaging techniques

#### 3.4.4.1. Radiographic evaluation

Right lateral recumbent position was used for taking the plain radiographs of the urinary bladder and lower urinary tract to locate the site of the calculi, if possible. The restraining of the animals for radiography was performed without sedation. Exposure factors were set on the basis of the size of the animal.

In three animals contrast radiography were performed, one animal to check the exact location of the urethral rupture and one for check the urethral patency after complete recovery from urolithiasis via tube cystostomy surgical management. Positive contrast normograde cystourethrography was performed for these two animals with Iohexol (35%) (OMNIPAQUE™, GE Healthcare Ireland Cork, Ireland) was diluted with normal saline at the ratio of 1:1. The diluted contrast medium was infused through the Foley's catheter till the urinary bladder was completely filled (**Figure 3.10**). Immediately radiographs were taken and findings were recorded. A bolus injection of nonionic iodinated compounds infused intravenously 2 ml/kg body weight before 15 minutes of radiography also performed for excretory urography in a patient to check the ureter and kidney condition.

**Figure 3.10:** Infusing contrast agent into the urinary bladder through Foley's catheter to check the urethral patency on right lateral recumbent position

### 3.4.4.2. Organ specific ultra-sonographic evaluation

#### 3.4.4.2.1. Ultrasonographic evaluation of urinary bladder

Urinary bladder examinations in all animals were performed under right lateral recumbent position without sedation. Anterior to the rudimentary teat was shaved to check the urinary bladder. Real time B-mode diagnostic ultrasound scanner equipped with 5.0 MHz convex curvilinear transducers was used for examination. Ultrasonic gel was applied to the prepared site for transabdominal scanning. Intact or ruptured urinary bladder associated with the thickness of the wall of urinary bladder was recorded.

**Figure 3.11:** Ultrasonographic examination of the urinary bladder by placing the probe on the prepubic region

#### 3.4.4.2.2. Ultrasonographic evaluation of kidney

Ultrasonography of the kidney was performed on non-sedated animals. The kidneys were examined from the paralumbar fossa by use of a 5.0 MHz convex curvilinear real time scanner. The area over the paralumbar fossa on right side was clipped, transmission gel was applied and the kidneys were examined. Both kidneys were scanned and measured from the right flank while the animals were on the standing position. To visualize the right kidney longitudinally, the transducer was always placed behind the last rib high on the paralumbar fossa. The transducer was held slightly oblique because the longitudinal axis of the right kidney did not lie horizontally in most cases. To visualize the left kidney longitudinally, the transducer was placed over the middle of the paralumbar fossa, parallel to the lumbar vertebrae.

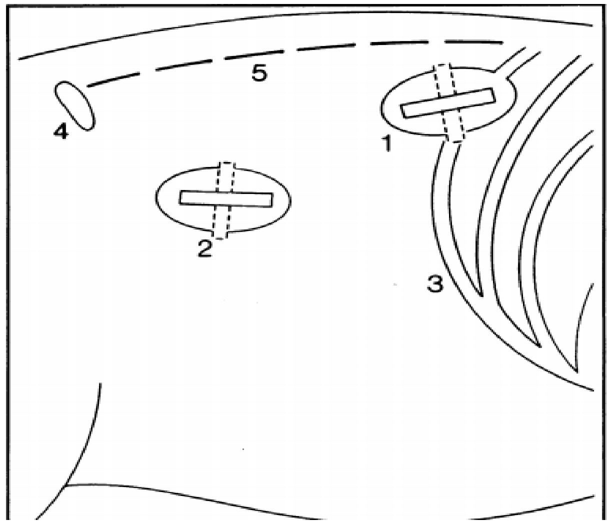


**Figure 3.12:** Ultrasonic transducer pointer for kidney examination from right side (longitudinally), 1= for right kidney. 2= for left kidney

Ultrasonographic measurements included the length of the kidney (the distance between the cranial and caudal renal poles, measured in the longitudinal plane) was measured on longitudinal images. On the same plane the width (distance between the medial and lateral aspects), diameter of the renal cortex and medullas were also measured in the longitudinal plane. All the measurements were made using electronic calipers. Besides of all these measurements, abnormal conditions of kidneys were also recorded.

**Figure 3.13:** longitudinal view of the right kidney examination by placing the probe behind the last rib of the paralumbar fossa

Ultrasonographic examination of the urethra, a 5.0 MHz convex curvilinear real time scanner was used to examine in right lateral recumbent position. The transducer was placed between the thighs to ultrasonographically visualize the urethra in the area of the sigmoid flexure to locate the calculi, if possible.

Both radiography and ultrasonography were performed to confirm the status of the urinary bladder, kidney, urethra to locate the urinary calculi and others abnormal conditions.

### 3.5. Statistical analysis

The animals were assigned into two groups, those with intact UB and ruptured UB for convenience of analysis of results. For data entry specially created MS excel spread data sheets were used and exported to Stata-13 (Stata Corp LP, 4905 Lakeway Drive, College Station, Texas, 77845, USA) for conducting data analysis. The data were statistically analyzed using independent one sample t-test at 5% level of significance using the reference range average mean as hypothetical value. $P<0.05$ values were considered significant.

# Chapter - 4: Results

The study population comprised 22 male ruminants (17 goats, 5 bovine calves). All affected animals had complete urinary retention at the time of presentation. In this study most important parameters have shown into two groups. One group with ruptured UB and another was intact UB for both goats and calves. In goats, 14 animals (14/17, 82.4%) had intact UB and 3 animals (3/17, 17.6%) had ruptured UB. In calves, 3 animals (3/5, 60.0%) had intact UB and 2 animals (2/5, 40.0%) had ruptured UB.

## 4.1. Medical history

All goats and calves suffering from obstructive urolithiasis included in this study were males. Castration status has been registered for all the cases; all bovine calves were intact and in goats 3 (3/17, 17.6%) were castrated and other 14 (14/17, 82.4%) were intact. The mean age (±SD) of the overall animal was 7.0 (±5.1) months (minimum, 1.5 months; maximum 18 months). The mean duration of illness (±SD) of the overall animal was 3.3 (±1.7) days (minimum 1 day; maximum 7 days). Defecation was normal in 19 animals. There was no defecation for last 2 days in 1 animal and scanty brown colored defecation in 2 animals for last 2 days.

## 4.2. Physiological parameters

The values for different physiological parameters both urinary bladder intact and ruptured cases were listed in **Table 4.1**. The mean ± SE value of rectal temperature for overall animal was 102.5 ± 0.2. The comparative mean ± SE values for rectal temperature (°F) were recorded in cases of obstructive urolithiasis in goats with intact and ruptured urinary bladder showing 102.6 ± 0.2 and 102.6 ± 0.9 respectively which were statistically non-significant ($p>0.05$). All values were within the reference range (102-104°F). The comparative mean ± SE values for rectal temperature (°F) were recorded in cases of obstructive urolithiasis in calves with intact and ruptured urinary bladder showing 102.03 ± 0.9 and 103.1 ± 1.1 respectively which were also statistically non-significant ($p>0.05$). All values were within the reference range (100.5-102.5 °F).

In goats, the mean ± SE heart rate was higher (113.6 ± 8.2) in all groups than the reference range (70-90 beats/minute). The mean ± SE heart rate in the cases with intact urinary bladder was 115.4 ± 9.9 beats/minute and with ruptured urinary bladder 105.3 ± 5.2 beats/minute which were statistically significant ($p<0.05$). In case of calves, the mean ± SE heart rate (89.0 ± 1.0 beats/minute) in the cases of ruptured urinary bladder was significantly ($p<0.05$) higher as compared to intact urinary bladder mean ± SE heart rate (103.3 ± 19.4 beats/minute). The mean ± SE heart rate was higher (97.6 ± 11.2) in all groups than the reference range (60-80 beats/minute).

In goats, the mean ± SE respiratory rate (breaths/minute) in this study was 37.6 ± 1.8 with a range of 17-48 breaths/ minute. In cases with intact urinary bladder, mean ± SE respiratory rate (breaths/minute) was 37.9 ± 2.1 and with ruptured urinary bladder was 36.0 ± 2.0. All these values were higher than the reference range (15-35 breaths/minute) which were statistically significant ($p<0.05$). In cases of calves, the mean ± SE respiratory rate (breaths/minute) in this study was 35.8 ± 1.1 with a range of 30-38 breaths/ minute. In cases with intact urinary bladder, mean ± SE respiratory rate (breaths/minute) was 35.3 ± 1.8 and with ruptured urinary bladder was 36.5 ± 1.5. All these values were non-significantly ($p>0.05$) higher than the reference range (10-30 breaths/minute). Comparatively the values in the cases with ruptured urinary bladder were higher than in the cases with intact urinary bladder.

Dehydration status of animals was measured by skin tenting test, which showed that cases of ruptured bladder had shrunken eyeballs, dull and depressed. Mild to moderate dehydration was noticed in those animals, which had intact urinary bladder. Dehydration percentage for all cases ranged from 4-10%.

**Table 4.1**: Comparative physiological parameters in calves and goats

| Parameters | Goat | | | | Reference range | Cattle | | | | Reference range |
|---|---|---|---|---|---|---|---|---|---|---|
| | Intact bladder (Mean ± SE) | P value | Ruptured bladder (Mean ± SE) | P value | | Intact bladder (Mean ± SE) | P value | Ruptured bladder (Mean ± SE) | P value | |
| **RT (°F)** | 102.6 ± 0.2 | 0.1 | 102.6 ± 0.9 | 0.7 | 102-104 | 102.03 ± 0.9 | 0.6 | 103.1 ± 1.1 | 0.4 | 100.5-102.5 |
| **HR (beats/minute)** | 115.4 ± 9.9 | 0.003 | 105.3 ± 5.2 | 0.04 | 70-90 | 103.3 ± 19.4 | 0.2 | 89.0 ± 1.0 | 0.03 | 60-80 |
| **RR (breaths/minute)** | 37.9 ± 2.1 | <0.001 | 36.0 ± 2.0 | 0.02 | 15-35 | 35.3 ± 1.8 | 0.1 | 36.5 ± 1.5 | 0.1 | 10-30 |

RT= Rectal temperature; RR= Respiratory rate; HR = Heart rate

**Reference range:** (Lin and Walz, 2014)

Others specific observation results were shown in **Table 4.2**.

Others specific observation included straining which was found in 77.3% cases, distended abdomen found in 45.5% cases, pains exhibited by 77.3% cases of obstructive urolithiasis.

**Table 4.2**: Summarized results of specific physical examination in calves and goats

| **Variables** | **No. of observation** | | **n** | **Percent (%)** |
|---|---|---|---|---|
| **Straining** | 22 | Yes | 17 | 77.3 |
| | 22 | No | 5 | 22.7 |
| **Abdomen status** | 22 | Normal | 12 | 54.5 |
| | 22 | Distended | 10 | 45.5 |
| **Expression of pain** | 22 | Yes[a] | 17 | 77.3 |
| | 22 | No | 5 | 22.7 |

[a]**Expression of pain =** teeth grinding, screaming, moaning, kicking to the abdomen etc.; **n =** number of animals

### 4.3. Laboratory analyses

#### 4.3.1. Hematological examination

The hematological values recorded in 22 clinical cases of obstructive urolithiasis were presented in **Table 4.3**.

The overall mean ± SE value of total erythrocytic count (TEC) in goats was 7.42 ± 0.3 million/mcl, which was slightly less than the reference range (8-18 million/mcl). In goats, the values of TEC were significantly ($p<0.05$) lower in cases of ruptured urinary bladder with the mean ± SE values of 6.1 ± 0.4 million/mcl as compared to the cases of intact urinary bladder 7.7 ± 0.3 million/mcl. In calves, the overall mean ± SE value of total erythrocytic count was 6.3 ± 0.3 million/mcl, which was within the reference range (5-10 million/mcl). The values of TEC were found higher in cases of ruptured urinary bladder with the mean ± SE values of 6.8 ± 0.6 million/mcl although it was statistically non-significant ($p>0.05$) as compared to the cases of intact urinary bladder 5.9 ± 0.3 million/mcl.

The overall mean ± SE values of total leukocytic count (TLC) in goats was 17.1 ± 1.0 thousand/mcl, which was higher than the reference range (4-13 thousand/mcl). The values of TLC were significantly lower in cases of ruptured urinary bladder with the mean ± SE values of 17.4 ± 1.2 thousand/mcl as compared to the cases of intact urinary bladder 15.9 ± 0.7 thousand/mcl. In calves, the overall mean ± SE values of total leukocytic count was 16.4 ± 0.9 thousand/mcl, which was higher than the reference range (4-12 thousand/mcl). The values of TLC were found higher in cases of ruptured urinary bladder with the mean ± SE values of 17.2 ± 2.6 million/mcl although it was non-significant ($p>0.05$) as compared to the cases of intact urinary bladder 15.8 ± 0.4 million/mcl which statistically significant ($p<0.05$).

The mean ± SE value for goat hemoglobin was 8.8 ± 0.2 g/dl, which was within the reference range (8-12 g/dl). The mean ± SE value of hemoglobin in the cases of intact urinary bladder was 8.9 ± 0.3 g/dl, while in cases of ruptured urinary bladder, the mean ± SE value of hemoglobin was 8.7 ± 0.3 g/dl. Comparatively, the values of hemoglobin were significantly ($p<0.05$) same in cases of ruptured urinary bladder than in the cases of intact urinary bladder. All values of hemoglobin were within the reference range (8-12 g/dl). The mean ± SE value for calves hemoglobin was 11.0 ± 0.8 g/dl which was within the reference range (8-15 g/dl). The mean ± SE value of hemoglobin in the cases of intact urinary bladder was 10.8 ± 1.01 g/dl, while in cases of ruptured urinary bladder, the mean ± SE value of hemoglobin was 11.2 ± 2.0 g/dl. Comparatively, values of hemoglobin were non-significantly higher in cases of ruptured urinary bladder than in the cases of intact urinary bladder. All values of hemoglobin were within the reference range (8-12 g/dl).

In goats, the mean ± SE value of packed cell volume (PCV) was 35.4 ± 2.0 percent with a range of 22 to 38 percent. The PCV percent values were significantly higher in the cases of ruptured urinary bladder (47.0 ± 1.0 %) than the clinical cases of obstructive urolithiasis with intact urinary bladder (32.9 ± 1.8 %). In calves, the mean ± SE value of PCV was 45.7 ± 3.9 percent with a range of 24 to 46 percent. The PCV percent values were non-significantly higher in the cases of ruptured urinary bladder (49.2 ± 11.2 %)

than the clinical cases of obstructive urolithiasis with intact urinary bladder (43.3 ± 1.3 %) although it was statistically significant ($p<0.05$).

In the differential leukocyte count, the mean ± SE value for neutrophils, lymphocytes, monocytes, eosinophils and basophils of goats were 65.5 ± 1.8%, 29.8 ± 1.7%, 2.4 ± 0.2%, 1.9 ± 0.2% and 0.1 ± 0.1% respectively. The values for these parameters ranged from 30-48%, 50-70%, 0-4%, 1-8% and 0-1%. The mean ± SE value for neutrophils, lymphocytes, monocytes, eosinophils and basophils in the cases of intact urinary bladder were 66.6 ± 2.1%, 28.6 ± 1.8%, 2.4 ± 0.2%, 2.1 ± 0.2% and 0.1 ± 0.1%, respectively. The mean ± SE value for neutrophils, lymphocytes, monocytes, eosinophils and basophils in the cases of ruptured urinary bladder were 60.7 ± 1.2%, 35.3 ± 1.8%, 2.7 ± 0.3%, 1.3 ± 0.3% and 0%, respectively. The values for intact and ruptured urinary bladder, neutrophils count is higher than the reference range, lymphocyte count is lower than the reference range but the monocytes, eosinophils and basophils in the differential leukocyte count were within the reference range. In calves, the mean ± SE value for neutrophils, lymphocytes, monocytes, eosinophils and basophils of goats were 69.8 ± 0.7%, 26.0 ± 0.7%, 2.4 ± 0.2%, 1.9 ± 0.0% and 0.1 ± 0.0%, respectively. The values for these parameters ranged from 15-45%, 45-75%, 2-7%, 2-20% and 0-2%. The mean ± SE neutrophils, lymphocytes, monocytes, eosinophils and basophils in the cases of intact urinary bladder were 69.7 ± 1.2%, 26.3 ± 1.2%, 2.0 ± 0.0%, 2.0 ± 0.0% and 0%, respectively. The mean ± SE value for neutrophils, lymphocytes, monocytes, eosinophils and basophils in the cases of ruptured urinary bladder were 70.0 ± 0.0%, 25.5 ± 0.5%, 2.5 ± 0.5%, 2.0 ± 0.0% and 0%, respectively. The values for intact and ruptured urinary bladder, neutrophils, lymphocytes, monocytes, eosinophils and basophils counts were more or less same.

**Table 4.3**: Comparison of changes in hematological parameters in calves and goats

| Parameters | Bladder status | Goat | | | | Cattle | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | Mean ± SE | P value | Reference range | N | Mean ± SE | P value | Reference range |
| TEC (million/mcl) | Intact | 14 | 7.7 ± 0.3 | <0.001 | 8-18 | 3 | 5.9 ± 0.3 | 0.02 | 5-10 |
| | Ruptured | 3 | 6.1 ± 0.4 | 0.004 | | 2 | 6.8 ± 0.6 | 0.3 | |
| TLC (thousand/mcl) | Intact | 14 | 17.4 ± 1.2 | <0.001 | 4-13 | 3 | 15.8 ± 0.4 | 0.002 | 4-12 |
| | Ruptured | 3 | 15.9 ± 0.7 | 0.01 | | 2 | 17.2 ± 2.6 | 0.2 | |
| Hb (g/dl) | Intact | 14 | 8.9 ± 0.3 | <0.001 | 8-12 | 3 | 10.8 ± 1.01 | 0.4 | 8-15 |
| | Ruptured | 3 | 8.7 ± 0.3 | <0.001 | | 2 | 11.2 ± 2.0 | 0.8 | |
| PCV (%) | Intact | 14 | 32.9 ± 1.8 | 0.1 | 22-38 | 3 | 43.3 ± 1.3 | 0.02 | 24-46 |
| | Ruptured | 3 | 47.0 ± 1.0 | 0.003 | | 2 | 49.2 ± 11.2 | 0.4 | |
| ESR (0 mm at 1st hour) | Intact | 14 | 0.04 ± 0.04 | 0.3 | 0 | 3 | 0 | - | 0 |
| | Ruptured | 3 | 0 ± 0 | - | | 2 | 0 | - | |
| Lymphocyte (%) | Intact | 14 | 28.6 ± 1.8 | <0.001 | 50-70 | 3 | 26.3 ± 1.2 | 0.001 | 45-75 |
| | Ruptured | 3 | 35.3 ± 1.8 | 0.005 | | 2 | 25.5 ± 0.5 | 0.009 | |
| Monocyte (%) | Intact | 14 | 2.4 ± 0.2 | 0.1 | 0-4 | 3 | 2.0 ± 0.0 | - | 2-7 |
| | Ruptured | 3 | 2.7 ± 0.3 | 0.2 | | 2 | 2.5 ± 0.5 | 0.1 | |
| Neutrophil (%) | Intact | 14 | 66.6 ± 2.1 | <0.001 | 30-48 | 3 | 69.7 ± 1.2 | <0.001 | 15-45 |
| | Ruptured | 3 | 60.7 ± 1.2 | 0.003 | | 2 | 70.0 ± 0.0 | - | |
| Eosinophil (%) | Intact | 14 | 2.1 ± 0.2 | <0.001 | 1-8 | 3 | 2.0 ± 0.0 | - | 2-20 |
| | Ruptured | 3 | 1.3 ± 0.3 | 0.008 | | 2 | 2.0 ± 0.0 | - | |
| Basophil (%) | Intact | 14 | 0.1 ± 0.1 | <0.001 | 0-1 | 3 | 0 | - | 0-2 |
| | Ruptured | 3 | 0 ± 0 | - | | 2 | 0 | - | |

**Reference range:** (D'Andrea and Sjogren, 2014)

### 4.3.2. Biochemical examination

The comparative blood biochemical values recorded in 22 clinical cases of obstructive urolithiaisis were presented in **Table 4.4**.

In goats, all values for total protein (TP) recorded during the present study were within the reference range (5.9-7.4 g/dl). The overall mean ± SE value of TP was 7.4 ± 0.3 g/dl. However, on comparative basis, the values for TP were non-significantly ($p>0.05$) lower in the cases of ruptured urinary bladder than in the cases of intact urinary bladder. In calves, all the values for TP recorded during the present study were within the reference range (5.7-8.1 g/dl). The overall mean ± SE value of TP was 5.5 ± 0.6 g/dl.

In cases of obstructive urolithiaisis of goats, the mean ± SE value of glucose was 111.3 ± 10.1 mg/dl which is higher than the reference range (60-100 mg/dl). Comparatively, in ruptured urinary bladder cases glucose value was non-significantly ($p>0.05$) lower than the intact urinary bladder cases. In calves, the mean ± SE value of glucose was 83.1 ± 7.8 mg/dl which is higher than the reference range (35-55 mg/dl).

In cases of goats, the mean ± SE value of blood urea nitrogen (BUN) of 17 clinical cases of obstructive urolithiasis was 61.5 ± 0.005 mg/dl, which were higher than the reference range (15-33 mg/dl). Comparatively the BUN values were significantly ($p<0.05$) higher in the cases of ruptured urinary bladder than the cases of intact urinary bladder. The mean ± SE value of BUN was 65.7 ± 3.6 and 60.6 ± 6.1 mg/dl in ruptured and intact urinary bladder cases respectively. In calves, the mean ± SE value of 5 clinical cases of obstructive urolithiasis was 58.7 ± 5.3 mg/dl, which were higher than the reference range (6-27 mg/dl). Comparatively the BUN values were lower in the cases of ruptured urinary bladder than the cases of intact urinary bladder. The mean ± SE value of BUN was 54.9 ± 0.7 and 61.2 ± 9.2 mg/dl in ruptured and intact urinary bladder cases respectively.

In clinical cases of obstructive urolithiasis of goats, the mean ± SE value of creatinine was 6.1 ± 0.6 mg/dl which were higher than the reference range (0.9-1.8 mg/dl). The mean ± SE value of creatinine in the cases of intact urinary bladder was 5.8 ± 0.7 mg/dl. The mean ± SE value of creatinine in the cases of ruptured urinary bladder was 7.5 ± 0.7 mg/dl. In comparison, the value was significantly ($p<0.05$) higher in the cases of ruptured urinary bladder as compared to the case of intact urinary bladder. In calves, the mean ± SE value of creatinine was 5.04 ± 0.4 which were higher than the reference range (1.0-2.7 mg/dl). The mean ± SE value of creatinine in the cases of intact urinary bladder was 4.9 ± 0.7 mg/dl. The mean ± SE value of creatinine in the cases of ruptured urinary bladder was 5.2 ± 0.6 mg/dl. The value was non-significantly ($p>0.05$) higher in the cases of ruptured urinary bladder than in the case of intact urinary bladder.

In cases of goats, the mean ± SE value of creatinine kinase (CK) of 17 clinical cases of obstructive urolithiasis was 438.8 ± 37.7 IU/L, which was higher than the reference range (104-220 IU/L). Comparatively the CK values were significantly ($p<0.05$) higher in the cases of ruptured urinary bladder than the cases of intact urinary bladder. The mean ± SE value of CK was 584.1 ± 97.3 and 407.7 ± 37.2 mg/dl in ruptured and intact urinary bladder cases respectively. In calves, the mean ± SE value of 5 clinical cases of obstructive urolithiasis CK was 477.7 ± 54.1 IU/L, which was higher than the normal reference range (35-280 IU/L). Comparatively the CK values were non-significantly ($p>0.05$) lower in the cases of ruptured urinary bladder than the cases of intact urinary bladder. The mean ± SE value of CK was 460.4 ± 34.3 and 489.2 ± 95.9 mg/dl in ruptured and intact urinary bladder cases respectively.

In goats, all values for sodium (Na) recorded during the present study were within the reference range (135-154 mmol/l). The overall mean ± SE value of sodium was 139.2 ± 4.6 mmol/l. however, on comparative basis, the values for sodium were non-significantly ($p>0.05$) higher in the cases of ruptured urinary bladder than in the cases of intact urinary bladder. In calves, all the values for sodium recorded during the present study were within the reference range (132-152 mmol/l). The overall mean ± SE value of sodium was 144.7 ± 6.2 mmol/l.

In cases of obstructive urolithiaisis of goats, the mean ± SE value of potassium (K) was 5.1 ± 0.3 mmol/l which was within the reference range (3.4-6.1 mmol/l). In calves, the mean ± SE value of potassium was 5.9 ± 0.9 mmol/l, which is towards to the higher reference range (3.9-5.8 mmol/l).

In goats, all values for chlorine (Cl) recorded during the present study were lower than the reference range (98-110 mmol/l). The overall mean ± SE value of chlorine was 93.4 ± 1.4 mmol/l. however, on comparative basis, the values for chlorine were significantly ($p<0.05$) higher in the cases of ruptured urinary bladder than in the cases of intact urinary bladder. In calves, all values for chlorine recorded during the present study were within the reference range (95-110 mmol/l). The overall mean ± SE value of chlorine was 98.1 ± 5.6 mmol/l.

In cases of obstructive urolithiaisis of goats, the mean ± SE value of phosphorus (P) was 8.02 ± 0.6 mg/dl which was within the reference range (4.2-9.8 mg/dl). In calves, the mean ± SE value of phosphorus was 8.3 ± 0.5 mmol/l which was higher than the reference range (4-7 mmol/l). In comparative study, the values for phosphorus were non-significantly ($p>0.05$) higher in the cases of ruptured urinary bladder than in the cases of intact urinary bladder.

**Table 4.4:** Comparison of changes in hemato-biochemical parameters in calves and goats

| Variables | Bladder status | Goat | | | | Cattle | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | Mean ± SE | P value | Reference range | N | Mean ± SE | P value | Reference range |
| Total protein (g/dl) | Intact | 14 | 7.7 ± 0.3 | 0.004 | 5.9-7.4 | 3 | 5.8 ± 0.9 | 0.3 | 5.7-8.1 |
| | Ruptured | 3 | 6.1 ± 0.2 | 0.1 | | 2 | 5.0 ± 1.2 | 0.4 | |
| Glucose (mg/dl) | Intact | 14 | 114.8 ± 12.1 | 0.01 | 60-100 | 3 | 83.0 ± 11.1 | 0.1 | 35-55 |
| | Ruptured | 3 | 94.5 ± 4.2 | 0.07 | | 2 | 83.3 ± 15.3 | 0.2 | |
| BUN (mg/dl) | Intact | 14 | 60.6 ± 6.1 | <0.001 | 15-33 | 3 | 61.2 ± 9.2 | 0.04 | 6-27 |
| | Ruptured | 3 | 65.7 ± 3.6 | 0.008 | | 2 | 54.9 ± 0.7 | 0.01 | |
| Creatinine (mg/dl) | Intact | 14 | 5.8 ± 0.7 | <0.001 | 0.9-1.8 | 3 | 4.9 ± 0.7 | 0.05 | 1-2.7 |
| | Ruptured | 3 | 7.5 ± 0.7 | 0.01 | | 2 | 5.2 ± 0.6 | 0.1 | |
| Creatinine Kinase (IU/L) | Intact | 14 | 407.7 ± 37.2 | <0.001 | 104-220 | 3 | 489.2 ± 95.9 | 0.07 | 35-280 |
| | Ruptured | 3 | 584.1 ± 97.3 | 0.05 | | 2 | 460.4 ± 34.3 | 0.07 | |
| Na (mmol/l) | Intact | 14 | 135.7 ± 5.1 | 0.1 | 135-154 | 3 | 144.9 ± 10.4 | 0.8 | 132-152 |
| | Ruptured | 3 | 155.7 ± 3.7 | 0.09 | | 2 | 144.5 ± 7.7 | 0.8 | |
| K (mmol/l) | Intact | 14 | 5.4 ± 0.4 | 0.1 | 3.4-6.1 | 3 | 5.5 ± 1.3 | 0.7 | 3.9-5.8 |
| | Ruptured | 3 | 3.9 ± 0.6 | 0.3 | | 2 | 6.4 ± 1.8 | 0.5 | |
| Cl (mmol/l) | Intact | 14 | 93.1 ± 1.7 | <0.001 | 98-110 | 3 | 97.8 ± 7.7 | 0.6 | 95-110 |
| | Ruptured | 3 | 94.7 ± 1.6 | 0.03 | | 2 | 98.5 ± 11.7 | 0.8 | |
| Ca (mg/dl) | Intact | 14 | 9.2 ± 0.3 | <0.001 | 9.2-11.6 | 3 | 9.2 ± 1.3 | 0.3 | 9.7-12.4 |
| | Ruptured | 3 | 9.8 ± 0.6 | 0.4 | | 2 | 9.2 ± 2.0 | 0.5 | |
| P(mg/dl) | Intact | 14 | 8.3 ± 0.7 | 0.08 | 4.2-9.8 | 3 | 7.7 ± 0.3 | 0.02 | 4-7 |
| | Ruptured | 3 | 6.8 ± 0.5 | 0.7 | | 2 | 9.05 ± 1.3 | 0.2 | |

**Reference range:** (D'Andrea and Sjogren, 2014)

### 4.3.3. Urinalysis

Result of urinalysis of obstructive urolithiasis cases were presented in **Table 4.5**.

In physical examination colored urine were reddish, pale yellow and straw yellow found in 70.6%, 23.5% and 5.9 cases of obstructive urolithiasis respectively. Glucose test of urine also found positive in 11.8% cases whereas in albumin test 35.3% cases were found positive. In microscopic examination, red blood cells, white blood cells, epithelial cast, uric acid cast and triple phosphate crystals (**Figure 4.1**) were found.

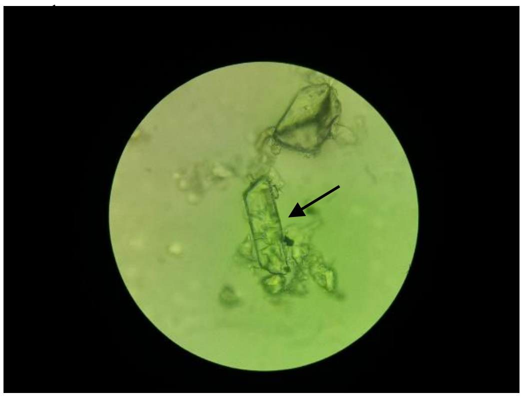

**Figure 4.1:** Prismatic triple phosphate (black solid arrow) crystal under microscope in urine sediment

**Figure 4.2:** Fine granular cast (black solid arrow) under microscope in urine sediment

**Table 4.5:** Physical and chemical parameters of urine analysis in calves and goats

| No. of animals examined | Major findings | Number | Percent (%) |
|---|---|---|---|
| **Color (17)** | Reddish | 12 | 70.6 |
| | Pale yellow | 4 | 23.5 |
| | Straw yellow | 1 | 5.9 |
| **Glucose (17)** | Positive | 2 | 11.8 |
| | Negative | 15 | 88.2 |
| **Albumin (17)** | Positive | 6 | 35.3 |
| | Negative | 11 | 64.7 |

Mean values of different parameters of urine analysis were presented on **Table 4.6**.

In goats, 14 clinical cases of obstructive urolithiaisis the mean ± SE value of specific gravity was 1.06 ± 0.01, which was higher than the reference range (1.015-1.045). In calves, 3 clinical cases of obstructive urolithiaisis the mean ± SE value of specific gravity was 1.05 ± 0.02, which was higher than the normal reference range (1.03-1.045).

The urinary pH of 14 clinical cases of obstructive urolithiasis in goats, the mean ± SE value of pH was 7.85 ± 0.2, which was within the reference range (7-8.5). In 3 calves of clinical cases, the mean ± SE value of pH was 7.9 ± 0.2, which was also within the reference range (7-8.5).

**Table 4.6:** Mean values of different parameter of urine analysis in calves and goats

| Variables | Bladder status | Goat | | | | Cattle | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | Mean ± SE | P value | Ref. range | N | Mean ± SE | P value | Ref. range |
| Specific gravity | Intact | 14 | 1.06 ± 0.01 | 0.05 | 1.015-1.045 | 3 | 1.04 ± 0.02 | 0.8 | 1.030-1.045 |
| | Ruptured | 0 | - | - | | 0 | - | - | |
| Urine pH | Intact | 14 | 7.9 ± 0.2 | 0.7 | 7-8.5 | 3 | 7.9 ± 0.2 | 0.6 | 7-8.5 |
| | Ruptured | 0 | - | - | | 0 | - | - | |

### 4.4. Diagnostic imaging analyses

### 4.4.1. Radiographic examination

Out of 22 animals plain radiography were performed in 20 animals (90.9%). But it was not possible to detect uroliths by plain radiography. Urinary bladder, sigmoid flexure, penile urethra all the sites were free from uroliths on plain radiography.

**Figure 4.3:** Distended urinary bladder (black solid arrow) without stone on plain radiography

Contrast radiographs carried out in 3 cases. Excretory urography obtained in one patient did not result in adequate visualization of the ureter for any blockage. Positive contrast normograde cystourethrography carried out in two patients. This technique allowed for identification of presence of urethral filling defect (**Figure 4.4**) suggestive of obstruction in one patient and urethral rupture (**Figure 4.5**) in one patient.

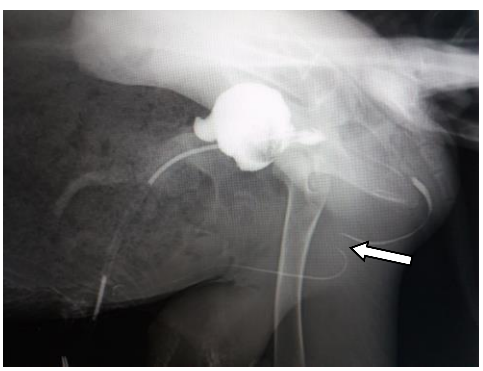

**Figure 4.4:** Urethral contrast filling defect due to obstruction (white solid arrow) on contrast radiography

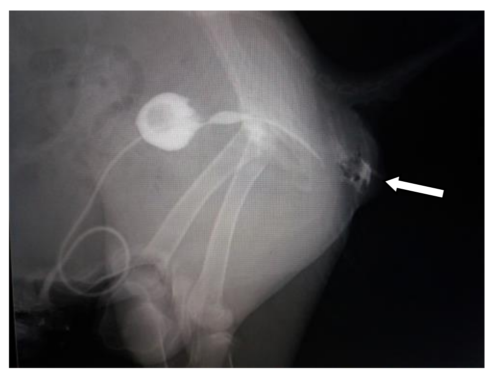

**Figure 4.5:** Detection of urethral rupture at pelvic urethral diverticulum (white solid arrow) on contrast radiography

### 4.4.2. Ultrasonographic examination

Both kidneys were observable from the right flank. Medulla was anechoic, although cortex was gray due to higher echogenicity than medulla. Measurements of length, width, cortex and medulla of both kidneys were shown in **Table 4.7**.

In goats, the mean ± SE value of length, width, cortex and medulla of right kidney was 57.1 ± 3.1, 34.1± 2.3, 7.3 ± 0.7 and 11.1 ± 0.8 mm respectively. The mean ± SE value of length, width, cortex and medulla of left kidney was 54.5 ± 2.9, 33.1± 2.4, 7.3 ± 0.7 and 10.9 ± 0.7 mm respectively. Ultrasound was not used to detect problems of bovine kidneys in this experiment.

**Table 4.7:** Mean values of comparative differences kidney measurements in goats

| **Variables** | **Goat** | | |
|---|---|---|---|
| | **Bladder status** | **N** | **Mean ± SE** |
| **Right kidney length (mm)** | Intact | 14 | 55.0 ± 3.1 |
| | Ruptured | 3 | 67.2 ± 7.3 |
| **Right kidney width (mm)** | Intact | 14 | 32.4 ± 2.2 |
| | Ruptured | 3 | 42.4 ± 5.9 |
| **Right kidney cortex (mm)** | Intact | 14 | 7.0 ± 0.8 |
| | Ruptured | 3 | 8.6 ± 1.4 |
| **Right kidney medulla (mm)** | Intact | 14 | 11.1 ± 0.9 |
| | Ruptured | 3 | 12.3 ± 1.2 |
| **Left kidney length (mm)** | Intact | 14 | 52.03 ± 2.9 |
| | Ruptured | 3 | 66.0 ± 6.4 |
| **Left kidney width (mm)** | Intact | 14 | 31.1 ± 2.4 |
| | Ruptured | 3 | 42.6 ± 5.2 |
| **Left kidney cortex (mm)** | Intact | 14 | 7.0 ± 0.8 |
| | Ruptured | 3 | 8.6 ± 1.5 |
| **Left kidney medulla (mm)** | Intact | 14 | 10.7 ± 0.8 |
| | Ruptured | 3 | 11.9 ± 1.3 |

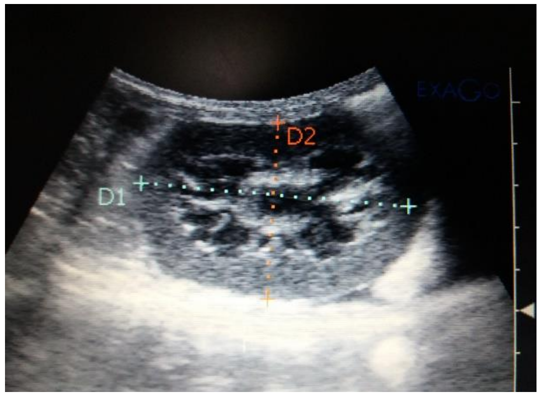


**Figure 4.6:** Sonographic measurements of length and width of goat kidney (D1= length, D2= width)

Measurements of ureter was not possible in this study by using ultrasonography. On ultrasonography, hydronephrosis (**Figure 4.7**) and perirenal fluid (**Figure 4.8**) were observed in 5 (29.4%) and 2 (11.8%) goats, respectively.

**Figure 4.7:** Hydronephrosis in kidney found on sonographic examination

**Figure 4.8**: Perirenal fluid accumulation seen on sonographic examination

The affections/lesions diagnosed on ultrasonographic examination of urinary tract in goats and calves suffering from obstructive urolithiasis are presented in **Table 4.8**. Urinary bladder was found with hyperechoic cystic wall (**Figure 4.11**) and anechoic lumen (urine). The wall thickness measurements of mean ± SE in goats was 2.01 ± 0.3 mm in intact urinary bladder, in cases of ruptured urinary bladder the mean ± SE value was 3.3 mm. Uroperitoneum was correctly diagnosed on ultrasonographic examination in 5 cases of this study. Confirmatory ultrasonographic diagnosis of urinary bladder rupture (**Figure 4.9**) was observed in 5 cases. The accuracy of ultrasound diagnosis was 100% in such cases. Urocystoliths were ultrasonographically diagnosed in all 17 cases of goats and calves suffering from complete urine retention of urine with 100% accuracy. Multiple small hyperechoic structures of varying size swirling (**Figure 4.10**) in the anechoic fluid (urine) without any acoustic shadows.

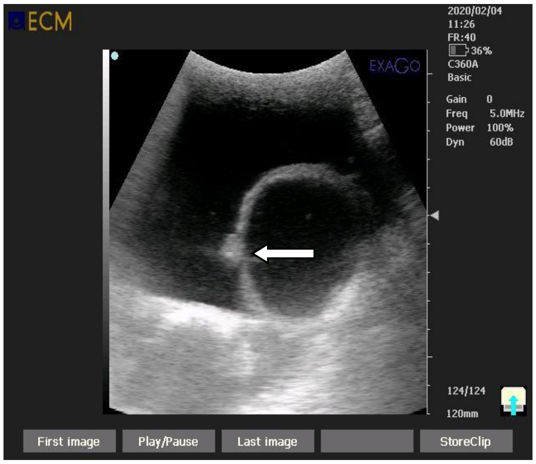


**Figure 4.9:** Transabdominal cystosonogram showing evident urinary bladder rupture (White solid arrow) with appreciable links in between uroperitoneum and cystic lumen


**Figure 4.10:** Transabdominal cystosonogram showing intraluminal multiple hyperechoic foci (urocystoliths) floating inside the urinary bladder

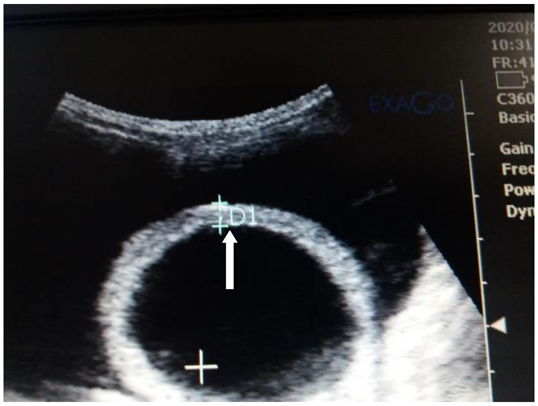


**Figure 4.11:** Transabdominal cystosonogram showing highly thickened hyperechoic single layered cystic wall (cystitis) (white solid arrow) with intact bladder

During this study, urethra was observed in 20 cases but urethral calculi was not possible to diagnose by using ultrasonography.

**Table 4.8**: Ultrasonographic diagnosis of urinary tract conditions in calves and goats

| Affections/lesions | No. of animals examined | Lesions detected on ultrasonographic examination | Accuracy (%) |
|---|---|---|---|
| **Cystitis** | 22 | 8 | 36.4 |
| **Uroperitoneum** | 22 | 5 | 22.7 |
| **Urocystoliths** | 22 | 17 | 77.3 |
| **Rupture of UB** | 22 | 5 | 22.7 |
| **Hydronephrosis** | 17 | 5 | 29.4 |
| **Perirenal fluid** | 17 | 2 | 11.8 |

# Chapter - 5: Discussion

Obstructive urolithiasis is a potentially fatal disease in ruminants. Our study describes the clinical findings, laboratory analysis and diagnostic imaging procedures in 22 animals with obstructive urolithiasis. While the high prevalence of the classical presentation with complete cessation of urination along with hematobiochemical changes and diagnostic imaging findings were confirmed, these results revealed that one or more of these cardinal signs were absent in a considerable number of cases, therefore their presence did not rule out a diagnosis of obstructive urolithiasis.

In this study, all the cases affecting obstructive urolithiaisis were recorded in males, which is consistent with Constable et al. (2017). Castrated males are reportedly predisposed to obstruction because of smaller urethral diameter that may occur because of lack of androgenic stimulation of urethral development (Smith and Sherman, 1994). Nonetheless, in our study more intact (82.4%) than castrated (17.6%) animals, confirming that intact males are also prone to obstructive urolithiasis, especially in presence of other risk factors such as concentrate rich feeding. This does not support this theory because the majority of the farmers rear their animals for selling occasionally in religious festival in Bangladesh.

In present study, the mean value of age was 7 months which was inconsistent with one findings reported by Sutradhar et al. (2018) with a high incidence of obstructive urolithiasis in 3 to 7 months of age. The urethral lumen in calves, irrespective of castration status, is probably lesser than the adult animals, as the urethral diameter and strength of urethralis muscle are controlled by testosterone hormone, which is lower in the younger male. The younger animals are unable to expel even the small calculi from the urethra ensuing in the urethral obstruction (Constable et al., 2017).

The mean duration of illness of the overall animal of the present study (3.3 days) corroborated to the Mahajan et al. (2017). The delay in the presentation of cases could be due to the delay in diagnosis as well as wait and watch tactics adopted by the field veterinarians after administering the medical therapy.

The rectal temperature recorded in this study was within the normal reference range. Normal mean rectal temperature in the cases of obstructive urolithiasis found within normal reference range which was inconsistent with the findings of Tamilmahan et al. (2014). The rectal temperature in ruptured urinary bladder cases was slightly higher in cases of calves than intact urinary bladder. But in goats, both for intact and ruptured urinary bladder rectal temperature was recorded within normal reference range. The variation in the rectal temperature could probably be due to the variation in the stage of uremia, duration of illness and degree of hemodynamic changes.

Mean heart rate was higher than the normal reference ranges in cases of obstructive urolithiasis, which could be attributed to the reflex response of baroreceptors 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). Inappetance and prolonged duration of illness and myocardial asthenia resulting from hyponatremia and hyperkalemia in ruminants could also be the possible causes of increased heart rate in the cases of obstructive urolithiasis (Constable et al., 2017). Increase in heart rate was more in the cases of ruptured urinary bladder in calves 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).

Respiration rate 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). Increased respiratory rate could be attributed to toxemia as a result of retention of metabolic waste products during obstructive urolithiasis. 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 (Smith, 1990). However, the findings of the present study differ from those who observed decreased respiratory rate in experimentally induced uremia in buffalo calves (Singh and Sahu, 1995).

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. Mild to 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 toxemia or due to deliberate deprivation of feed and water (Constable et al., 2017). 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 (George et al., 2007).

The most specific signs of obstructive urolithiasis, with attempts at urination often accompanied by colic, straining and further expressions of pain (Van Metre et al., 1996). In our study, expression of pain was recorded in 77.3% cases (17 of 22) of all animals. Most of the patients were exhibited in pain with intact urinary bladder than the ruptured urinary bladder. Abdominal pain could be due to the urine pressurized to the nerve ending of the urinary bladder.

In hematological examination, the TLC was higher in the cases of ruptured urinary bladder than in the cases of intact urinary bladder, thus confirming the similar findings with (Sastry, 1983; Swenson and Reece, 1993; Brar et al. 1999; Constable et al., 2017). Pain and stressful conditions may be the possible reasons for leukocytosis in the cases of ruptured urinary bladder (Jasper and Jain, 1986)

The mean hemoglobin value was within the normal reference range in our study which is consistent with other studies (Sastry, 1983; Swenson and Reece, 1993; Brar et al., 1999; Constable et al., 2017). Comparatively, the mean value of PCV recorded in the ruptured urinary bladder cases of this study was higher than in the cases of intact urinary bladder which was higher than the normal reference range. A high PCV results hemoconcentration probably due to dehydration (Sharma et al., 1982; Sockett et al., 1986; Constable et al., 2017). In cases of obstructive urolithiasis, dehydration results from reduced water intake and loss of appetite, as anorexia was the common clinical symptom in all animals.

The values of different leukocytes obtained during this study were within the normal range reported was consistent with other reports (Sastry, 1983; Swenson and Reece, 1993; Brar et al., 1999; Constable et al., 2017) but the neutrophil percent was higher and lymphocyte percent was lower in this study. The higher value of neutrophils percent could be due to stress in which there is release of adrenaline that reduces stickiness of neutrophils with erythrocytes causing an increase in circulating neutrophil pool (Sastry, 2000). Low levels of lymphocyte can be seen in some bacterial infections, aplastic anaemia, and in some forms of leukemia while high value observed in viral infections, and seen some form of leukemia (Pradhan, 2016).

After biochemical examination, the BUN value was recorded higher than the normal reference range. These findings are in agreement with those of Villar et al. (2003) who also reported elevated levels of BUN values to the extent of 160 mg/dl (114.24 mmol/l) in cases of obstructive urolithiasis. The findings are also in agreement with those of Sheehan et al. (1994) who reported impaired clearance of urea and creatinine in urinary tract obstruction. Urea is a nitrogenous waste product, which is formed in the liver as the end product of amino acid breakdown and is excreted by kidney into urine (Kerr, 2002). In obstructive urolithiasis, urine gets accumulated into the urinary bladder for more than normal period of time. The urea gets reabsorbed into the systemic circulation and causes uremia. Further, backflow of urine may create pressure over the kidney to reduce the urine production by decreasing glomerular filtration rate and ultimately decrease urea excretion in urine (Sharma et al., 2006). This mechanism explains the reason behind the raised values of BUN in the cases of obstructive urolithiasis. Blood urea nitrogen in the cases of ruptured urinary bladder was higher than that in the intact urinary bladder cases, which could be due to movement of urea from the high concentration in peritoneal cavity to the interstitial and intravascular compartments. The higher values for BUN in ruptured bladder cases are in total consonance with those of Smith (2002) and Donecker and Bellamy (1982) who reported more profound biochemical alterations in cases with ruptured bladder. This mechanism may help in maintaining the blood urea level in normal range for some time but in long standing cases, high blood urea nitrogen may occur in spite of recycling of urea through rumen (Sharma et al., 2006).

The mean value for creatinine in the clinical cases of obstructive urolithiasis was found higher than the normal reference range. Similar findings have also been reported by other workers (Singh et al., 1984a; Sockett et al., 1986; Singh et al., 2005; Sharma et al., 2006). Creatinine is the waste product of creatinine, which is involved in the muscle contraction. The concentration of creatinine in blood increases mainly because of excretory dysfunction and renal damage. Its concentration in blood is not influenced by diet, therefore, creatinine levels in blood could be a better prognostic indicator of renal function as compared to urea

(Kerr, 2002). The rise in the creatinine level might be due to increased resorption of creatinine from the bladder due to prolonged stasis of urine in the intact urinary bladder and renal damage due to hydronephrosis (Singh et al., 2005). In the present study, the plasma levels of creatinine were higher in the cases of ruptured urinary bladder than in the cases of intact urinary bladder. These findings are in agreement with those of Smith (2002) and Donecker and Bellamy (1982) who reported more profound serum biochemical alterations in ruptured bladder cases than those without ruptured bladder. Higher values of creatinine in the ruptured cases could be due to movement of creatinine from the peritoneal fluid to blood (Donecker and Bellamy, 1982).

During the present study, total proteins were found within the normal reference range, but towards higher side, which could be due to hemoconcentration caused by decrease in fluid volume caused by dehydration. However, the findings are also in contrast with many other workers Donecker and Bellamy (1982), Singh et al. (1984b) and Kumar et al. (1998) found increased TP, while Peshin et al. (1985) and Pandey and Singh (1989) reported decreased TP values. Variability in the results reported by different workers could be attributed to different levels of hydration in the animals of their studies.

The mean values of creatinine kinase found higher than the normal reference range in this study which was similar with the others workers (Riedi et al., 2018). Actually, increase value of creatinine kinase has no specific reason in obstructive urolithiasis cases. So, increase value of creatinine kinase could be due to the increase muscle activity resulting from frequent straining and colic, or transportation (Carlson, 2015) and were likely not directly associated with the pathogenesis of primary disease.

The mean values for sodium during the present study were within the normal reference range. These findings corroborated the observations of (Singh et al., 1984a) who did not find any significant change in sodium levels due to uremia in sheep and obstructive urolithiasis in calves. The findings are also in total agreement with those of Sharma et al. (2005) who observed no change in sodium levels in clinical cases of obstructive urolithiasis in bovine calves. In contrast, Donecker and Bellamy (1982) and Sockett et al. (1986) observed hyponatremia in uremic animals having ruptured urinary bladder. The variability in the sodium value may occur depending upon the ability of the animal to regulate sodium concentration by alternate route (Singh and Singh, 1990). When urinary bladder rupture takes place and urine invades the peritoneal cavity a number of movements in fluid and electrolytes take place. Because of low concentrations of sodium and chloride in urine, these ions move from interstitial compartment into the peritoneal cavity and depress the plasma levels (Donecker and Bellamy, 1982; Sockett et al., 1986).

Calcium and phosphorous are two major minerals whose blood concentration depends on each other. Approximately 80% of the total body phosphorous and 99% of calcium are found in the teeth and bones. Remaining 20% of total phosphate is distributed in soft tissues to play a part in many metabolic pathways (Kaneko et al., 1997; Kerr, 2002). The calcium and phosphorus imbalance can lead to a number of metabolic disturbances including struvite lithiasis in animals given a diet high in the phosphorous and low in calcium. In this present study the mean value of calcium within the normal reference range but hyperphosphatemia observed in bovine calves. A decreased glomerular filtration rate might be the cause of hyperphosphatemia in cattle with renal damage (Divers et al., 1989). Greater degree of dehydration and subsequent hemoconcentration could also be responsible for slightly higher phosphorous in ruptured urinary bladder cases. These findings are in total consonance with those of Brobst et al. (1978) and Donecker and Bellamy (1982)

In this study the mean value of chlorine is lower than the normal reference value. The high prevalence of hypochloridemic metabolic alkalosis (decreased Cl and increased TCO2 concentrations) in the goats with uncomplicated urethral blockage was similar to the situation in cattle with renal diseases (Divers et al., 1982).

Straw yellow, pale yellow and reddish colored urine was noticed in this present study. Maximum 70.6% cases noticed reddish colored urine. This study result is inconsistent with other study of Braun (2005) and Sharma et al. (2006), who also recorded light yellow, dark yellow, pale pink colored urine with clear and cloudy appearance in adult bovine and young calves suffering from obstructive urolithiasis. The variation in the color of urine of the affected animals on day zero probably could be due to the variation in concentration of urine, accumulation of sediment and hemorrhage.

Specific gravity of urine is a useful indicator of renal concentrating ability and an important tool to evaluate the kidney function, as the loss of concentrating ability is among the first signs of renal disease. In this present study, the mean value of specific gravity was higher than the normal reference range which could be due to the moderate intake fluid by the animals and contamination of urine samples by the cellular debris and proteins.

Urine pH is a measurement of the kidneys ability to conserve hydrogen ions and provides a rough estimate of the kidneys acid base status. In this study, the mean value of pH within the normal reference range. In ruminants, urine is neutral or slightly alkaline due to feeding of cereal diets or forages. Alkaline pH of this study might be due to decomposition of urea to ammonia (Carlson, 1990) and/or urinary tract infection which was recorded in 68% cases.

Normally urine does not contain proteins (Carlson, 1990). During this study proteinuria was found in 35.3% cases. It might be due to acute nephritis or inflammatory exudation resulting from pyelitis, urethritis, cystitis and urolithiasis.

Casts are cylindrical structures that are formed from cells, cell fragments, and macromolecules present in the lumens of renal tubules. Proteinuria, pyuria, hematuria and cell desquamation of renal origin may provide the material for cast formation. Urine flow rate and pH are factors that interact with these components (Finco, 1997). In this present study, epithelial cast, RBC sediment, WBC were found.

Feeding of high concentrate, low roughage diet resulting in low Ca: P ratio (Ahmed et al., 1989) also favors the precipitation of triple phosphate crystals (Larson, 1996). In this present study triple phosphate found in microscopic examination which was consistent with the above study. Hippuric acid, calcium oxalate, calcium carbonate and tyrosine crystals recorded in this study were found in acidic pH, thus confirming the observations of Osborne et al. (1995).

Plain and contrast radiography are usually used imaging techniques for evaluation of the urinary tract lesions in dogs, cats, swine, small and large ruminant (Palmer et al., 1998; Misk and Semieka, 2003; Kyles et al., 2005). During this study not a single plain radiograph was diagnostic, which could be due to employment of insufficient exposure factors. The findings are in consonance with those of Tyagi and Singh (1996), who stated that attempts to locate calculi by radiographic examination, was not successful. The observations also match with those of Magda (2006). Contrarily, (Misk and Semieka, 2003) found radiography a highly diagnostic method in bovine cases of urethral obstruction. Calculi containing calcium carbonate, calcium oxalate, and/or silica were readily visible on plain radiography of the abdomen and pelvic region of small ruminants, whereas struvite calculi were not visible (Kinsley et al., 2013).

Positive contrast normograde cystourethrography through the tube cystostomy catheter could allow the best visualization of the lower urinary tract. This would also enable the assessment of the obstructive lesions and can be used to diagnose the site of urethral rupture, besides locating the calculi and monitoring their dissolution status during the course of medical treatment (Palmer et al., 1998). During this study one patient had seen urethral rupture on pelvic urethral part of the urinary tract and another showed the urethral contrast filling defect which could be due to the obstruction of the urinary tract. Excretory urography in one patient no obstruction of the ureter could be visualized, which again could be due to insufficient exposure factors. The inability to adequately visualize the ureters by excretory urography has been described previously in small ruminants (Cegarra and Lewis, 1977; Singh et al., 1983).

Renal ultrasound is one of several imaging modalities in the evaluation of patients with acute renal disorders; it provides excellent anatomical information without exposure to radiation hazards; however, it is limited in its assessment of renal function (Noble and Brown, 2004). In this study, the right and left kidneys could be seen from the right side and were positioned with their longitudinal axis parallel to the vertebrae in almost all animals. The urinary tract of the goats was examined using the methods described for sheep (Braun et al., 1992) and goats (Steininger and Braun, 2012). Vosough and Mozaffari (2009) measured the length, width, cortex and medulla of both kidneys in 10 female Raiini goat; they found that the length, width, cortex and medullary diameter for the right kidney were 44.5, 30.0, 8.7 and 26.6 mm respectively. For the left kidney, the length, width, cortex and medullary diameter were found to be 43.7, 29.8, 8.2 and 25.4 mm respectively. This is not similar to our study and it could be due to breed differences. Khan et al. (2003) measured the kidneys in Pakistani female goats at slaughter houses. They found that the length and width of the right kidney were as follows: 61.8 ± 2.3 and 32.4 ± 0.39, for the left kidney 63.2 ± 0.38 and 31.9 ± 0.36 mm. This is also not in accordance with our study and again it could be due to breed differences.

Hydronephrosis is most commonly seen with obstruction of the ureters or lower urinary tract (Penninck, 2008). Obstructive processes of the lower urinary tract (calculi, stricture, tumor) result in progressive dilation of the renal pelvis and ureter (hydroureter) with progressive alteration of the renal architecture. In our study, several cases were encountered with hydronephrosis having with varying degree of renal pelvis distention which was consistent with the above study.

In this study, among the 22 cases of obstructive urolithiasis cases 11.8% cases encountered perirenal fluid accumulation surrounding the kidney. Lal et al. (2017) found 14% of the parenchymal disease may develop fluid around the kidney. Small amount of perirenal renal fluid may be seen due to the infectious cause, toxicities, acute kidney injury. Also, neoplasia may cause variable degree of perirenal fluid accumulation. Sometimes, large amounts of perirenal fluid is difficult to differentiate from retroperitoneal fluid (Lisciandro, 2014)

Ultrasound offers a non-invasive method for diagnosis of urolithiasis, localization of urethral calculi, as well as diagnosis of dilated urethra, cystitis, urethritis and rupture of the urethra or the urinary bladder (Braun, 1993). Braun (1993) also did not feel any necessity to anaesthetize the animals for ultrasound examination. Magda (2006) also conducted ultrasound examination without any sedation in cattle and buffalo calves. Restraining of animals in lateral recumbency on the examination table facilitated the easy transabdominal scanning of urinary bladder, percutaneous scanning of penile urethra. Most of the previous studies have been conducted in standing position and reportedly in a successful manner (Magda, 2006; Floeck, 2007).

Ultrasound is ideally suited for examination of urinary bladder, as small bladder not detected by abdominal palpation or radiography can be identified by ultrasound (Biller, 1990). The bladder was oval, pear and very irregular in shape with hyperechoic cystic wall and anechoic lumen (urine), depending upon the extent of its distension and rupture. The degree of bladder distension usually reflects the visibility of its wall layers. In extremely distended cases, cystic wall appeared as a single hyperechoic layer, while in ruptured and moderately distended bladders, different layers of cystic wall could be differentiated. These findings corroborate with those of Ozturk et al. (2007). Cystitis characterized by highly thickened and single layered hyperechoic cystic wall, and with or without the hyperechoic material within the lumen and/or attached to the mucosal layer but without any acoustic shadow, was observed. Uroperitoneum is evident as anechoic fluid accumulation in the abdomen, within which the organs appear to be floating (Braun et al., 2006). In 5 cases of this study uroperitoneum was correctly diagnosed on ultrasonography. Urinary bladder rupture is suspected whenever there is accumulation of urine into the peritoneal cavity and little urine in the bladder lumen. Bladder rupture is also suspected when it is not visible on ultrasound examination especially in large cattle (Braun et al., 2006). In the present study confirmatory diagnosis of urinary bladder rupture was possible only in 5 cases. The hyperechoic structure showing acoustic shadow is a confirmation of the calculi in the kidneys, urinary bladder or urethra (Saini and Singh, 2002). In all of the intact urinary bladder cases in this study ultrasonographic examination of urinary bladder revealed multiple small hyperechoic structures of varying size swirling in the anechoic fluid (urine) without any acoustic shadows. However small calculi do not always produce distal acoustic shadowing, when they are smaller than the active element diameter of the transducer or calculi are not in the focal zone (Voros et al., 1993). Braun et al. (1992) also found urinary calculi as hyperechoic material with acoustic shadow in rams suffering from obstructive urolithiasis. In our study, urethroliths could not diagnose by using ultrasonography which was in consistent with the findings of Magda (2006). It could be due to the insufficient frequency ultrasonic transducer.

# Chapter - 6: Conclusions

Investigations on clinical studies of obstructive urolithiasis in goats and bovine calves, recorded from January, 2019 to December, 2019 at Sahedul Alam Quadery Teaching Veterinary Hospital (SAQTVH), Chattogram Veterinary and Animal Sciences University, Chattogram, were carried out with the objectives of study the changes of blood, serum, urine and anatomical structure of urinary tract during urolithiasis by hematobiochemical, radiographical and ultrasonographical approaches. There were twenty-two clinical cases of obstructive urolithiasis were used in this study. Diagnosis of the disease was made on the basis of anuric history, clinical signs, radiographic, ultrasonographic and hematobiochemical examinations. Especially, ultrasonography proved as a very useful aid in diagnosis of urolithiasis (assessing UB condition) in calves and goats.

On the basis of results of this study, following conclusions are drawn:

1. Obstructive urolithiasis causes severe alterations in hematobiochemical profile of the animal including TLC, PCV, BUN, Creatinine, Sodium, Chlorine, Calcium and inorganic Phosphorus.
2. Radiography, ultrasonography and urinalysis are very useful in specific diagnosis and allow for further decisions regarding management of obstructive urolithiasis in ruminants.

# Chapter - 7: Limitations and Recommendations

## Limitations:

Small sample size of this investigation was not representative to the population due to short period of the study. Lacking of several modern diagnostic methods like CT scan without contrast medium, MRI, digital tomosynthesis, isotope renography, hormone analysis (parathormone) used in modern urological centres for investigating urolithiaisis. Inaccessibility of high frequency ultrasound transducer which is helpful for detection of urethral stones. Lacking of modern laboratory facilities to identify the type of stone.

## Recommendations:

Though a significantly positive conclusion was found in this study, however, large sized population will provide more specified result for better conclusion. So, it is suggested that combining of several diagnostic protocol will confirm the diagnosis of obstructive urolithiasis and helps to take a complete decision for better management of the obstructive urolithiasis cases.

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## Appendix

### A Questionnaire for Diagnostic Evaluation of the Obstructive Urolithiasis in Ruminants

Case No. Case Reg. No. Date:

Owner Name: Address: Mobile No.

Species: Breed: Age:

Sex: BCS: Body Weight:

**Anamnesis/Cl. History:**

Onset: Sudden/Gradual Duration of Illness: Defecation: Y/N
Urination: Y/N

F/H: Normal/Loss of Appetite/Off-fed/Other……………………...

Roughage (Y/N) ……….kg/day Concentrate (Y/N) …………………kg/day

Housing System: Intensive/Semi-intensive/Tethered/Free-range/Other……...

**Cl. Examination:**

Rec. Temp: Heart Rate: Resp. Rate:

Visible mucous membrane: Pale/Pink/Icteric/Cyanotic/Other…………….

General Attitude: Alert/Dull/Depressed/Other……………………………

Dehydration: Normal/Mild/Moderate/Severe Posture: Normal/defective
Gait: Normal/Lameness Abdomen size: Normal/distended/Gaunt

**Observations:**

1.

2.

## Laboratory Analysis

## Hematology Profile

| Name of the Test | Result | Normal Range |
|---|---|---|
| Total Count of TEC | | |
| Total Count of TLC | | |
| Hb (%) | | |
| PCV (%) | | |
| ESR | | |
| **DLC** ⇩ | | |
| Lymphocyte (%) | | |
| Monocyte (%) | | |
| Neutrophil (%) | | |
| Eosinophil (%) | | |
| Basophil (%) | | |

## Biochemistry Profile

| Name of the Test | Result | Normal Range |
|---|---|---|
| Glucose | | |
| Total Protein | | |
| BUN | | |
| Creatinine | | |
| Creatinine Kinase | | |
| Albumin | | |
| Na | | |
| K | | |
| Calcium | | |
| P | | |
| Cl | | |

## Urine Analyses

| Name of the Test | Result |
|---|---|
| Color | |
| Sp. Gravity | |
| Urine $P^H$ | |
| Glucose | |
| Protein | |
| Microscopic Examination of Urolith | |

## Radiographic Evaluation

Plain Radiography:

Contrast Radiography:

## Ultra-sonographic Evaluation

Kidney:

Ureter:

U. bladder:

Urethra:

Diagnosis:

## Biography

**Sreekanta Biswas** passed the Secondary School Certificate Examination in 2008 followed by Higher Secondary Certificate in 2010. He has obtained his Doctor of Veterinary Medicine (DVM) Degree in 2017 from Chattogram Veterinary and Animal Sciences University (CVASU), Bangladesh. Now, he is a candidate for the degree of MS in Surgery, under the department of Medicine and Surgery, Chattogram Veterinary and Animal Sciences University (CVASU). He has published several scientific articles in national and international journals. He has great interest on small and large animal surgery.