RADIOGRAPHIC EVALUATION AND MANAGEMENT OF LOWER URINARY TRACT DISORDERS IN DOGS

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DECLARATION

I hereby declare that this thesis, entitled **"RADIOGRAPHIC EVALUATION AND MANAGEMENT OF LOWER URINARY TRACT DISORDERS IN DOGS"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that the thesis entitled **"RADIOGRAPHIC EVALUATION AND MANAGEMENT OF LOWER URINARY TRACT DISORDERS IN DOGS"** is a record of research work done independently by **Sheeja, V.M.,** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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Introduction

1. INTRODUCTION

The lower urinary tract consists of urinary bladder, urethra and prostate gland. The common diseases affecting the lower urinary tract were urolithiasis, cystitis, urethral stricture, urinary incontinence, diseases of prostate gland and tumours of urinary bladder.

Urolithiasis is the most frequent cause of lower urinary tract disorder in dogs. More than 99 per cent of uroliths in dogs occur in the lower urinary tract either in the urinary bladder, urethra or in both. Males are more commonly affected with urethral blockage than females due to long and narrow urethra. The most common sites of urethral obstruction in dogs are at the level of ventral groove of os penis and regions just behind the os penis.

Urinary tract infection (UTI) is more common in females due to shorter and broad urethra which makes them less barrier to ascending migration of bacteria (Osborne *et al.,* 1985). Close proximity of urethral opening for faecal contamination also add to the cause.

The architecture of the structures in lower urinary tact makes them well suited for investigation by a variety of imaging modes. Survey and contrast radiography and ultrasonography are the principal imaging techniques available for evaluation of the lower urinary tract (Johnston and Feeney, 1984). Cystoscopy is a valuable diagnostic modality in small animals and it permits direct visualization of the vagina, urethral orifice, urethra, bladder and ureteral openings (Waldron, 2002) but the equipments are costly.

Survey radiography is a simple and inexpensive quick diagnostic tool that will provide useful information on the size, shape, location and radiographic opacity of the structures in the caudal abdomen. A contrast cystogram and urethrogram could

be helpful to evaluate for radiolucent calculi, intraluminal mass lesions, blood clots, and strictures in cases with recurrent episodes (Adams and Syme, 2005).

Culture and sensitivity tests of urine samples will favour the identification of causative agents and selection of suitable antibiotics for controlling the infections.

In males prescrotal urethrotomy is the common surgical procedure for the removal of urethral calculi. Large cystic calculi are removed by cystotomy but recurrences are often reported (Damodaran, 2004).

A study on the type and composition of the calculi would help in understanding the nature of calculi present and to give suitable medicinal and dietary management to prevent recurrence. Since the incidence of urinary calculi and cystitis are very common in pet animals the study was undertaken with the following objectives:

1. To evaluate the radiographic changes associated with various disease conditions of the lower urinary tract.

2. To evolve suitable remedial measures including surgical technique.

Review of Literature

2. REVIEW OF LITERATURE.

2.1. REGIONAL ANATOMY OF LOWER URINARY TRACT

2.1.1. Urinary Bladder

The bladder is a hollow muscular organ that receives urine from the kidneys through both ureters and functions as a reservoir until urine expulsion through the urethra. Its function as a storage receptacle and as a force behind urine expulsion is facilitated by the extensive interdigitating smooth muscle fibres of the bladder wall that are known collectively as the detrusor muscle. In dogs and cats the bladder is loosely supported by peritoneal reflections that form bilateral lateral ligaments and a single midventral ligament. The lateral ligaments connect the bladder to the lateral walls of the pelvic canal and enclose the ureters and umbilical arteries. The ventral ligament connects the bladder to the pelvic symphysis and linea alba and contain urachus in the foetus, however it is avascular in the adult. Size and location of the bladder depend on the volume of the urine present. In dogs the bladder usually lies partially with in the pelvic canal when empty, but it moves cranially and ventrally in to the caudal abdomen as it distends.

The bladder is divided in to three regions consisting of the apex (cranial portion), neck (caudal portion) and body (mid portion). Internally, the trigone is found on the dorsal surface of the bladder neck. The base of the triangular area is formed by the two ureteral orifice and the apex is the urethral orifice. The mucosa of the bladder is made up of transitional epithelium that routinely exfoliates. The mucosa responds to chronic inflammation or urinary tract infection by hyperplasia and hypertrophy which causes thickening of the bladder wall (Waldron, 2002).

2.1.2. The urethra

2.1.2.1. Male dog: The urethra in the male dog can be divided in to prostatic, pelvic (membranous) and cavernous (penile) parts. Smooth muscle is present throughout the length of the urethra and striated muscle is present in the wall of the distal two thirds of the urethra in the male dog. The muscles of the urethra are innervated by adrenergic receptor of the proximal urethra. The striated muscle of the membraneous portion of the urethra receives its innervations from the pudental nerve (Waldron, 2002).

2.1.2.2. Female dog: The urethra in female dog is relatively short and 68 per cent to 78 per cent urethra is connective tissue. Smooth muscle is eight per cent to 12.5 per cent of the volume of the wall of the urethra and striated muscle is found predominantly in the distal third of the urethra occupying 9 per cent to 11 per cent of the urethral wall volume (Waldron, 2002).

2.1.3. Blood and nerve supply to urinary bladder

The major blood supply to the bladder is the caudal vesical artery, a branch of the urogenital artery. In about 50% of the adult dogs, there is a patent cranial vesical artery that supplies a portion of the cranial bladder and is a branch of the umbilical artery. Venous blood drains in to the internal pudental veins, and lymphatic drain in to the hypogastric sub lumbar and medial iliac lymph nodes.

Innervation of the bladder is complex, with both autonomic and somatic output. The hypogastric nerve provides sympathetic innervation of the bladder. Somatic innervation originates in fibers from the sacral spinal cord that form the pudental nerve. One branch of the pudental nerve supplies the external urethral sphincter and others innervate the perineal area (Waldron, 2002).

2.1.4. Blood and nerve supply to the urethra

2.1.4.1. Male dog: The prostatic urethra is supplied with blood from the prostatic artery, which in turn derived from the internal pudental artery. The membranous portion of the urethra is supplied by small urethral arteries that branch off the internal pudental artery, or the prostatic artery. The penile urethra is supplied with blood from the artery of the urethral bulb. The urethral veins are the satellites of the arteries and drain in to the pudental vein. Lymphatics drain in to the iliac, hypogastric, superficial inguinal and sacral lymph nodes (Osborne *et a l.*, 1985).

2.1.4.2. Female dog: The blood supply to the female dog's urethra is derived from the caudal vesical artery and internal pudental artery. Lymphatic drainage is similar to that of male dogs (Osborne *et a l.*, 1985).

2.2. INCIDENCE OF LOWER URINARY TRACT DISORDERS

Lulich *et al.* (2000) reported that the most commonly reported diseases affecting the lower urinary tract were cystitis (40%), urinary incontinence (24%) and urolithiasis (18%).

Sosnar *et al.* (2005) reported that urolithiasis was the third most frequent diseases of the lower urinary tract in dogs, where 90 to 98 per cent of uroliths were located.

2.2.1. Age

2.2.1.1. Urolithiasis: Brown *et al.* (1977a) found that most dogs with calculi were between three and seven years of age with a mean age of 5.5 years. The mean age of dogs varied according to type of calculi viz., phosphate calculi (6 years), cystine (4.8 years), urate (5.5 years), oxalate (7.8 years) and for those with carbonate (12.3 years).

Osborne *et al.* (1981) reported the mean age of dog with struvite urolithiasis was six years.

Lewis and Morris (1984) reported that over 97 per cent of uroliths in males were in less than one year of age.

Case *et al.* (1992) reported that mean age at first incidence of cystine urolithiasis was approximately four and half years and mean age at second occurrence was approximately one year later.

Case *et al.* (1993) in a study of 275 cases of urolithiasis found that the mean age of dogs at the time of first episode of calculus formation in Dalmatian was 4.5 years for males and 5.5 years for females.

Thilagar *et al.* (1996) reported that the incidence of occurrence of calculi in urethra and bladder was highest between six to nine years of age.

Ling *et al.* (1998a) analyzed 11,000 specimens of urinary calculi in dogs and found that average age at which diagnosis were made at 6.9 years in males and 6.47 years in females.

Weichselbaum *et al.* (1998) reported that average age of dog with calcium oxalate uroliths was nine years and of silica uroliths was 5.8 years.

According to Lekcharoensuk *et al.* (2000) middle aged castrated dogs had increased risk for calcium oxalate urolith and stated that urolith formation was increased with increasing age.

Damodaran (2004) observed that mean age of incidence of urolithiasis was 6.3 years.

Houston *et al.* (2004) reported that average age for female dog with struvite urolithiasis was 5.7 years and in male dog was six years.

2.2.1.2. Urinary Tract Infections: Bartges (2004) reported bacterial urinary tract infection occurred in 14 per cent of all dogs during their life time and the incidence increases with age.

2.2.1.3. Neoplasms of the bladder and urethra: Straufuss and Dean (1975) reported that mean age of dogs with urinary bladder neoplasia was 9.5 years.

Krawiec (1991) reported that mean age of dogs with urinary bladder neoplasia at the time of diagnosis was 10.5 years.

Goett and Degner (2003) reviewed that average age of dogs affected with urinary bladder tumour was 10 years.

According to Heng *et al.* (2006) the age of incidence of bladder wall leiomyoma and leiomyosarcomas in dogs were 12.5 and six years respectively.

2.2.1.4. Prostatic Diseases: Krawiec and Heflin (1992) reported that mean age at onset of prostatic disease was 8.9 years.

2.2.2. Breed

2.2.2.1. Urolithiasis: Zontine (1975) reported that urolithiasis was common in Dachshunds, Dalmatian, Scottish Terrier and Pekingese breeds.

Brown *et al.* (1977a) observed higher incidence of calculi formation in Miniature Schnauzer, Dachshund, Dalmatian, Pug, Bull Dog, Welsh Corgi, Beagle and Basset Hound.

Osborne *et al.* (1981) reported that struvite urolithiasis was common in Miniature Schnauzers, Dachshunds, Poodles, Scottish Terriers, Beagles, Pekingese and Welsh Corgies.

Osborne *et al.* (1986) observed that out of 734 patients of urolithiasis, uroliths were most commonly detected in Miniature Schnauzers (22.3 %), Miniature Poodles (10%), Dachshunds (5 %), Shih Tzus (5%), Cocker Spaniel (3 %), Dalmatian (3 %) and Yorkshire Terrier (3 %).

Case *et al.* (1993) reported that the risk of forming urate containing calculi was higher in Dalmatians where as the risk of forming calculi containing other minerals were consistently lower in Dalmatians.

Thilagar *et al.* (1996) observed highest incidence of urolithiasis in non descript (30 %) followed by Pomeranian (17.7 %), Alsatian (16.2 %) Doberman (7.7 %) and Labrador (7.7 %).

Ling *et al.* (1998c) reported that mixed breed group represented increased risk of calculi formation followed by Dachshunds, Shetland Sheep Dogs and Bichon Frises.

Weichselbaum *et al.* (1998) reported that breeds with relatively higher likelihood of urocystolith included English Bull Dog, Pekingese, Pug, Welsh Corgi and West Highland White.

Damodaran (2004) observed the incidence of urolithiasis was more in German Shepherd Dog followed by Pomeranian and Labrador.

Singh *et al.* (2005) recorded that majority of urolithiasis were seen in Spitz followed by Doberman.

According to Sosnar *et al.* (2005) small breeds and chondrodystrophic breeds were particularly susceptible to urolithiasis.

2.2.2.2. Neoplasms of the bladder and urethra: Strafuss and Dean (1975) reported there was no breed predisposition in the occurrence of bladder tumour.

Krawiec (1991) observed that out of 21 cases of bladder tumour, West Highland White Terrier and Shetland Sheep Dog showed higher incidence followed by Miniature Schnauzer, Coonhound and Beagle.

2.2.2.3. Prostatic Diseases: Krawiec and Heflin (1992) reported that Doberman Pinscher was the most common breed with prostate disease followed by German Shepherds.

Kutzler and Yeager (2005) observed that Doberman Pinschers and German Shepherds were the most common breeds affected with prostate disease.

2.2.3. Sex

2.2.3.1. Urolithiasis: Brown *et al.* (1977a) reported the incidence of phosphate calculi in females as 60 per cent and in males as 40 per cent.

According to Osborne *et al.* (1981) struvite urolithiasis was more common in females (60 %) than males (40%).

Osborne *et al.* (1986) observed uroliths occurred more frequently in females than male dogs. Metabolic uroliths occurred predominantly in male dogs rather than in female dogs.

Lulich *et al.* (1991) reported that the risk for males developing calcium oxalate uroliths was three times greater than females.

According to Thilagar *et al.* (1996) the incidence of urolithiasis was more in males (84.6%) and less in females (15.4%). In males, single large sized urethral calculi were common in large breeds while many small sized calculi were more in smaller breeds.

Hess *et al.* (1998) observed that males were at increased risk for developing calcium oxalate uroliths than females

Ling *et al.* (1998c) reported that struvite apatite and urate containing calculi were more common in female dogs where as oxalate, cystine, silica, brushite and xanthine containing calculi were more common in male dogs.

Lekcharoensuk *et al.* (2000) reported that male dog had three times greater risk for developing urolith than females.

Nandi *et al.* (2003) reported the incidence of canine urolithiasis in male and female was 51.22 and 48.78 per cent respectively in and around Kolkata.

Damodaran (2004) reported the incidence of urolithiasis was more in males than females.

Singh *et al.* (2005) observed that the number of males affected with urolithiasis was higher than females.

2.2.3.2. Urinary Tract Infections: Osborne *et al.* (1985) reported female dogs were more affected with urinary tract infection (UTI) than males. Shorter and broader urethra in female makes them less barrier to ascending migration of bacteria.

According to Bartges (2004) female dogs were more affected with urinary tract infection than males

2.2.3.3. Neoplasms of the bladder and urethra: Osborne *et al.* (1985) reported that bladder neoplasms were more common in females.

The incidence of primary urethral tumours was reported in females by Filippich *et al.* (1988)

Krawiec (1991) reported that fairly even distribution of bladder cancer between both sexes.

Goett and Degner (2003) reviewed that older spayed female dogs were most often affected with urinary bladder tumours.

2.3. ETIOLOGY

2.3.1. Urolithiasis

Marretta *et al.* (1981) reported that portosystemic shunt led to ammonium and uric acid calculi in dogs other than Dalmatians.

Osborne *et al.* (1981) reported that infection of the urinary tract with urease producing bacteria especially staphylococci plays an important role in struvite urolith formation.

Ling *et al.* (1984) reported that urinary infection caused by coagulase-positive staphylococci (*Staphylococcus aureus, S. intermedius)* was a causative factor in the formation of struvite urinary calculi.

Osborne *et al.* (1986) stated that urolithiasis should not be considered as a single disease but rather as sequelae of one or more underlying abnormalities. Thus urolithiasis might be conceptually defined as formation of uroliths as a consequence of multiple congenital and or acquired pathophysiologic process that result in increased concentration of less soluble crystalloids in urine.

Clark and Panciera (1992) reported that most cases of calcium phosphate urolithiasis in dogs were associated with hyperparathyroidism.

According to Adams and Syme (2005) the mineral content of water might be a potential factor in calcium oxalate urolith in humans.

Carvalho *et al.* (2006) stated that defective urinary crystallization inhibition in Miniature Schnauzer due to low level of nephrocalcin compared to other dogs make more susceptible to calcium oxalate urolithiasis.

2.3.2. Urinary Tract Infections

Thomas (1979) reported that intermittent urethral catheterization leads to urinary tract infection.

Oxenford *et al.* (1984) reported that predisposing factors such as cystic calculi, spinal cord lesion, renal failure, hyper adrenocorticism, prostatic hyperplasia, diabetes mellitus and urinary tract neoplasms leads to urinary tract infection.

According to Lees and Rogers (1986) seven genera of bacteria (Escherichia, Staphylococcus, Streptococcus, Proteus, Klebsiella, pseudomonas and Enterobacter) were responsible for most episodes of urinary tract infections in dogs and cats.

According to Moreau (1990) hind limb weakness due to spinal disorders could predisposed for urinary tract infection by causing urinary stasis.

Shaw (1990) reported that urolithiasis, neoplasia, persistent urachal diverticula, ectopic ureters, urine retention secondary to urinary tract obstruction or to upper or lower motor neuron disease involving urinary bladder and chronic bacterial prostatitis were the lower urinary tract disorders that could result in recurrent and relapsing infections.

Sturges and LeCouteur (2002) reported spinal cord injury caused loss of voluntary control of urination and large volume of urine accumulation caused development of retention cystitis.

2.3.3. Neoplasms of the bladder and urethra

Krawiec (1991) reviewed a number of factors implicated as causes of bladder cancer. Industrial chemicals, (e.g.-beta naphthylamine and benzidine) metabolites of tryptophan, chronic irritation, foreign bodies, viruses, bracken fern and certain drugs had been associated with introduction of bladder tumours.

2.3.4. Other causes

Brown (2002) reported that neurogenic urinary incontinence was due to upper motor neuron lesions and non-neurogenic incontinence was due to ectopic ureter, bladder atony and urethral incompetence. According to the author any condition that caused over distention of bladder might resulted in detrusor damage and atony and this was a disorder of the voiding phase of urination leading to over flow incontinence that might responded to pharmacological therapy. The author also reported that bethanechol was a cholinergic agent and enhanced detrusor contractions.

Lipscomb (2004) reported that causes of lower urinary tract obstruction include urolithiasis, urethral stricture, prostatomegaly, a retroflexed bladder in a perineal hernia, severe urethral inflammation, bladder neck or urethral neoplasia and urethral trauma.

2.4. CLINICAL SIGNS

2.4.1. Urolithiasis

Rubin (1990a) stated that dysuria, haematuria, stranguria, inappropriate urination and pollakiuria were common clinical manifestations of disorders of bladder and urethra.

Lipscomb (2004) and Singh *et al.* (2005) described clinical signs exhibited by the dogs with urolithiasis as dysuria, haematuria, intermittent urination, dribbling, anuria and mild to moderate dehydration. Other signs were emesis, anorexia, depression and weight loss.

2.4.2. Urinary Tract Infections

Lees and Rogers (1986) reported simple urethrocystitis was characterized by signs of bladder and urethral disease (e.g. pollakiuria or dysuria) and might be acute or chronic.

Bartges (2004) reported clinical signs of cystitis were dysuria pollakiuria, gross haematuria at the end of micturition and cloudy urine with abnormal odour.

2.4.3. Neoplasms of the bladder and urethra

Straufuss and Dean (1975) reported the clinical signs of bladder tumour as continuous or intermittent haematuria with increased frequency of urination from associated cystitis and decreased bladder capacity. The tumour may completely or partially obstruct the urethra or ureters.

Krawiec (1991) observed that most common clinical sign for the dog with bladder tumour was urinary incontinence. Stranguria, haematuria and dysuria were the other signs exhibited.

Singh and Mohindroo (2007) reported persistent or intermittent haematuria, increased frequency of urination, stranguria and dysuria were the clinical signs of bladder tumour.

2.4.4. Prostatic Diseases

According to Krawiec and Heflin (1992) the most common clinical signs of prostatic disease were rectal tenesmus, haematuria, anorexia, urethral discharge, vomiting, lethargy and infertility. Prostatic abscesses might develop secondary to chronic bacterial prostatitis and could result in life threatening fulminating toxaemia. Abscesses might be large enough to interfere with defecation and urination.

Kutzler and Yeager (2005) reported rectal tenesmus, haematuria urethral discharge and pyrexia were the common clinical signs associated with prostatic diseases.

2.5. LOCATION AND TYPE OF CALCULI IN UROLITHIASIS

Finco (1971) reported post os penis as the common site of urethral obstruction of urinary calculi.

Osborne *et al.* (1986) reported the jack stone shape typically seen in silica urolith and occasionally in case of calcium oxalate uroliths.

According to Lulich *et al.* (1991) struvite calculi were the most predominant type of calculi in dogs followed by calcium oxalate.

Thilagar *et al.* (1996) reported that post os penis (24.7%) was the common site of urethral obstruction followed by ischial arch (18.4%), ventral groove of the os penis (9.2%) and entire length of the urethra (4.7%).

According to Ling *et al.* (1998c) struvite calculi were the most predominant type of calculi in dogs followed by calcium oxalate uroliths.

Ling *et al.* (1998d) reported that 79 per cent of calculi were in the bladder and 40 per cent in urethra in male dogs where as in females 93 per cent were in the bladder and 2.5 per cent in the urethra.

Weichselbaum *et al.* (1998) described shapes of calculi as faceted, ovoid, irregular and round. The pyramidal shape for magnesium ammonium phosphate, rosette shape for oxalate, and jackstone shape almost exclusively for silica urocystolith. Faceted or faceted combination was principally magnesium ammonium phosphate. The authors also reported 85 per cent of magnesium ammonium phosphate calculi were light tan in colour, 85 per cent of ammonium urate calculi were green in colour and 72 per cent of magnesium ammonium phosphate was smooth. According to the authors, urate calculi were radiolucent.

Nandi *et al.* (2003) the occurrence of stone formation in urethra, bladder and both in urethra and bladder in males were 28.57, 52.38, and 14.38 per cent respectively. In females, in urethra and bladder was 10 and 90 per cent respectively and no calculi was seen both in the urethra and bladder in females.

Damodaran (2004) reported the groove of os penis as the common site of obstruction followed by post os penis.

According to Adams and Syme (2005) the jack stone shape was typically seen in silica urolith and occasionally in case of calcium oxalate uroliths.

According to Gatoria *et al.* (2005) groove of os penis was the common site of obstruction followed by post os penis.

Singh *et al.* (2005) reported calcium oxalate was the most predominant type of calculi followed by calcium carbonate phosphate and magnesium ammonium phosphate.

Sosnar *et al.* (2005) reported that the occurrence of struvite was 39 per cent, calcium oxalate was 36 per cent, urate was 11.2 per cent and mixed urolith was 6.1 per cent. The authors also reported that annual incidence of calcium oxalate was continuously increased from 26.5 per cent in 1997 to 44 per cent in 2002 and prevalence of calculi of various mineral types were differing according to geographical area.

2.6. DIAGNOSIS

2.6.1. Radiography

2.6.1.1. Survey radiography: Brown *et al.* (1977a) in a retrospective analysis of 438 cases of canine urolithiasis found that most of the calculi were radio opaque and located in the bladder and urethra.

Johnston and Feeney (1984) reported that survey radiography was a simple, inexpensive and quick technique that would provide useful information on the size, shape, location and radiographic opacity of the structures in the caudal abdomen.

Bartges and Lane (2002) graded the radioopacity of the calculi as calcium oxalate (++++), struvite (+ to ++++), urate and uric acid (0 to ++).

Bartges (2004) observed thickening of the bladder wall in cystitis in survey radiography.

2.6.1.2. Contrast radiography: Osborne and Jessen (1971) reported the use of double contrast cystography with negative and positive contrast medium. Air, carbon dioxide and nitrous oxide were used as negative contrast agents and barium micro pulverized sulphate in water was used as positive contrast agent.

Ackerman *et al.* (1972) observed fatal air embolism associated with pneumocystography and pneumourethrography in a dog

Ticer *et al.* (1980) described contrast urethrography for detection of radiolucent calculi.

Johnston and Feeney (1984) reported double contrast cystography was the technique of choice for evaluation of the bladder wall and for detection of intra luminal filling defects within the urinary bladder. The authors also suggested that in patients with suspected disease of the prostate gland or urethra, positive contrast antegrade or retrograde urethrocystography was ideal.

Herrtage and Dennis (1987) stated that conventional water soluble iodine preparations diluted to contain about 150 mg Iodine /ml was adequate for positive and double contrast cystography and urethrography. The commonest agents used were the sodium and meglumine salts of iothalamic, diatrizoic or metrizoic acid.

Burk and Ackerman (1996) described that evaluation of cystogram should be performed by paying special attention to location, shape and integrity of the bladder and the thickness and regularity of the bladder wall. The authors also suggested that the double contrast cystogram as the preferred technique to study the urinary bladder, because it provided best evaluation of mucosal surface. The positive contrast cystogrphy was indicated when bladder rupture was suspected. The retrograde urethrogram evaluated the entire urethra. The water soluble radioopaque contrast medium was used at dose rate of 0.5 ml / kg body weight with a maximum volume of 20 millilitres for the largest male dog.

Lavin (1994) stated that cystogram was indicated for an animal exhibiting unresponsive clinical signs such as haematuria, crystalluria, bacturia, dysuria, anuria and incontinence. In negative-contrast cystogram (pneumocystogram), slowly infuse negative contrast agent such as air at a dose rate of 10 ml/kg body weight.

Ravindran *et al.* (2001) conducted double contrast cystography in a dog with chronic urethro-cystitis and obseved thickening and mucosal ulceration of urinary bladder.

Park and Wrigley (2002) performed positive-contrast cystography by injecting a 20 per cent solution of an organic iodide at a dose rate of 10 millilitres (range of 3.5 - 13 millilitres) contrast media per kg body weight via urethral catheter. In double contrast cystography, the dose of positive contrast medium was 1 to 3 millilitres for dog weighing less than 25 lb and 3 to 6 millilitres for dog weighing more than 25 lb.

Essman (2005) reported in case of positive contrast cystography, organic iodide solution diluted to a 20 per cent solution with sterile water at a dose of 10 ml/ kg body weight was used. The volume of contrast media will vary depending on the patient's body weight and the disease condition occurring in the bladder. The author conducted double contrast cystography by infusing a small amount (0.5-1 millilitres for a cat to 3-6 millilitres for a large dog) of a non diluted contrast medium in to the bladder followed by a negative contrast medium at a dose rate of 10ml/kg body weight.

Heng *et al.* (2006) reported that contrast radiography such as positive and / or double contrast cystography was used in the diagnosis of bladder wall neoplasm and identified as the presence of an intraluminal filling defect caused by the mass that was not visible on survey radiography.

2.6.2. Ultrasonography

Johnston and Feeney (1984) stated that diagnostic ultrasound could be used to assess the internal architecture of canine prostate gland.

Barsanti and Finco (1986) stated that ultrasonography had the advantage of indicating prostatic consistency, size, shape and presence of fluid cavities versus solid tissue masses.

Rubin (1990b) reported that ultrasonography was a useful compliment to radiography for evaluating the kidneys, urinary bladder and prostate gland.

Voros *et al.* (1993) reported that urinary calculi were usually highly echogenic and were quite easy to detect within the anechoic lumen of the bladder. Large calculi (0.5-1.0 cm in diameter) produced intense acoustic shadowing and small (0.2-0.5 cm in diameter) produced reverberation.

Mattoon and Nyland (1995) described prostatic abscess as both hypoechoic and hyperoechoic areas in the enlarged prostate gland.

Nyland *et al.* (1995) noticed thickening of the urinary bladder wall in cystitis, wall thickening was most pronounced cranioventrally and became generalized in severe cases.

Park and Wrigley (2002) reported the ultrasonographic finding of blood clot as hyperechoic, non shadowing and mobile masses.

Kundu and Ghosh (2006) conducted ultrasonographic study of urinary bladder and evaluated the efficacy of ultrasonographic diagnosis in different diseases of urinary bladder in dogs.

Verma *et al.* (2006) reported cystoliths as hyperechoic structure with strong distal acoustic shadow and in cystitis, double layered appearance with thickening of bladder wall and eroded in some cases along with small to appreciable amount of cellular debris.

Singh and Mohindroo (2007) diagnosed bladder neoplasia by ultrasonography as echogenic intraluminal mass.

2.6.3. Cystoscopy

Brearly and Copper (1987) proved cystoscopy as a valuable technique for investigation of lower urinary tract disorders such as cystitis, neoplasia of bladder, urethra and prostate, ectopic ureter, calculi and prostatic hypertrophy. They used standard rigid cystoscopes for the bitches and a long fine flexible fiber-optic endoscope for the male dogs.

Messer *et al.* (2005) reported that cystoscopy could be an invaluable adjunct to routine diagnostic procedures of the lower urinary tract in dogs and cats. It allowed direct visualization of the areas of interest and enabled biopsies of mass lesions

2.6.4. Urinalysis

Comer and Ling (1981) reported that the antepubic cystocentesis was the best method for collection of uncontaminated urine sample.

Osborne *et al.* (1981) described struvite and apatite calculi in alkaline pH and acidic pH in cystine where as in case of ammonium urate, calcium oxalate, and silica the pH was found to be variable.

Hoff (1986) observed alkaline pH, turbid urine, numerous RBC, WBC and epithelial cells in urine of a dog with struvite calculi.

Osborne *et al.* (1986) described the characteristics of urine crystals. Calcium oxalate dihydrate crystals appeared in urine as small, colourless envelopes (octahedral form) and calcium oxalate monohydrates as small colourless spindles, hemp seeds or dumbbells, appeared as three to six sided prisms. Ammonium urate appeared as yellow brown spherulites, thorn apples, cystine as flat, colourless hexagonal plates and calcium phosphate appeared as amorphous or long thin prism.

Abdullahi and Adeyanju (1987) reported haematuria, pyuria, proteinuria and bacteriuria in a dog with urolithiasis.

Varshney *et al.* (1988) revealed presence of epithelial casts, RBC, pus cells, protein and alkaline pH in urine of dogs with urolithiasis.

Rubin (1990a) reported haematuria, proteinuria, pyuria and turbid urine in urine of dogs affected with urinary tract infections. According to the author, proteinuria results from leakage of serum proteins in to the urinary tract at sites of haemorrhage or exudation

According to Bartges (2004) haematuria, proteinuria, pyuria and turbid urine in urine of dogs affected with urinary tract infections.

Adams and Syme (2005) reported acidic pH in calcium oxalate, ammonium urate, xanthine and cystine calculi. The authors also reported calcium oxalate dihydrate crystals appeared as square envelops and calcium oxalate monohydrate as dumbbell or picket-fence shaped.

Bartges (2005) reported that the pH of urine was acidic in *Escherichia coli* infection and in staphylococcal infection, urease produced by the Staphylococci metabolized urea to ammonia resulted in alkaline pH. The author also detected proteinuria in bladder tumour.

According to Cowgill and Francey (2005) in acute renal failure, both the renal concentrating and diluting ability became impaired resulted in a urine specific gravity between 1.008 and 1.018 and also reported there was proteinuria in ureamia.

Reine and Langston (2005) stated that urinalysis as an essential part of the diagnostic evaluation for all urinary and many metabolic diseases. They reported urine dipstick was a convenient method for biochemical analysis of urine. According to the authors, increased numbers of epithelial cells were seen in infection, inflammation, irritation and neoplasia. Pyuria was noticed in prostatic diseases.

2.6.5. Culture and Sensitivity test of urine sample

Brown *et al.* (1977a) studied 259 cases of urolithiasis and found that most common organism isolated were Staphylococcus spp, *E. coli*, Proteus spp, Streptococcus spp and Klebsiella spp. Most of the bacteria were sensitive to gentamicin, chloramphenicol, nitrofurantoin, cephalothin and methanamine mandelate.

Brown *et al.* (1977b) reported that most dogs with phosphate calculi had Staphylococcal infections, where as cultures from dogs with cystine calculi had wide range of bacteria.

Lewis and Morris (1984) reported struvite calculi were associated with Staphylococcus infection and the alkaline urine.

According to Oxenford *et al.* (1984) the percentage of urinary tract infections in male dogs from which a single species was isolated were Proteus spp-12.5 per cent, *E. coli* 87.5 per cent and Staphylococcus spp-71.4 per cent.

Struvite calculi were associated with staphylococcus infection and alkaline urine (Osborne *et al.*, 1986)

Varshney *et al.* (1988) observed that cultural examination of urine of a bitch with calculi composed of phosphate, calcium and magnesium revealed the presence of *E.coli* organisms which were sensitive to ampicillin, gentamicin and nitrofurantoin.

Shaw (1990) reviewed that infection by *E. coli* was responsible for 30-40 per cent of urinary tract infections (UTI) in dogs and cats. Proteus spp, *Staphylococcus intermedius* and alpha hemolytic streptococci together accounted for about 35 to 50 per cent of UTIs.

According to Krawiec (1991) there was concomitant urinary tract infection associated with bladder tumour.

Clark and Panciera (1992) performed urine culture in a young dog with calcium phosphate urolithiasis yielded haemolytic *Escherichia Coli*, hemolytic Streptococcus spp and pseudomonas spp.

Case *et al.* (1993) isolated bacteria from 22 of 49 cases of urinary calculi (45%) and found that coagulase positive bacteria accounted for 62.5 per cent of the isolate.

Ling *et al.* (1998a) reported that the bacteria could be isolated from 65% of females and 44 per cent of males with urolithiasis. *Staphylococcus intermedius* was associated most often from either sex.

Bartges (2004) reported that the most common pathogen cause urinary tract infection was *E. coli* followed by Staphylococcus, Streptococci and Proteus spp.

Damodaran (2004) reported that the bacterial isolates from urine of dogs with urolithiasis were sensitive to ciprofloxacin followed by ampicillin and amoxycillin.

Kutzler and Yeager (2005) reported the most common pathogen that causes bacterial prostatitis was *E.coli*.

2.6.6. Haematology and serum biochemistry

Osborne *et al.* (1985) and Sinha *et al.* (1986) in urolithiasis cases noted that there was decrease in haematocrit, red cell count and haemoglobin.

Lulich *et al.* (1991) reported leukocytosis with neutrophilia in urolithiasis.

Barsanti and Finco (1986) observed neutrophilic leucocytosis in dogs with prostatic abscessation.

Varshney *et al.* (1988) reported elevated BUN and creatinine in urolithiasis.

Rubin (1990a) reported that in most cases of cystitis and urethritis, there was no change in blood biochemistry and leucocytosis was observed in acute prostatitis.

Benjamin (2005) reported an increase in blood urea nitrogen, serum calcium, serum phosphorus, potassium and a decrease in sodium in post renal urinary tract infections.

Cowgill and Francey (2005) reported hyperkalemia and hyponatraemia was a common and life threatening electrolyte disorder in acute ureamia.

According to Gaschen and Teske (2005) thrombocytopenia was one of the most common haemostatic abnormalities in cancer patients and the life span of the platelets could be shortened, especially with metastatic tumour.

Sharma *et al.* (2005) observed that obstructive urolithiasis was characterized by elevated haemoglobin and PCV, neutrophilia with concomitant lymphocytopenia, increased serum urea nitrogen and creatinine pre operatively.

Verma *et al.* (2006) reported neutrophilic leukocytosis and elevated BUN and creatinine in seven dogs with cystoliths.

Singh and Mohindroo (2007) observed anaemia due to constant blood loss and neutrophilic leukocytosis in bladder tumour.

2.6.7. Other diagnostic methods

Ling *et al.* (1991) observed that the best diagnostic method of analysis of xanthine containing calculi was high pressure liquid chromatography as it being quantitative, sensitive and accurate and could be conducted on small amount (1-2 mg) of crystalline material.

Krawiec and Heflin (1992) reported that hyperplastic prostate was symmetrically large and moderately firm by rectal palpation. Prostatitis was diagnosed by cytological evaluation, bacteriologic culture and antimicrobial testing of prostatic fluid.

2.7. SEQUELAE OF URETHRAL OBSTRUCTION

Hall *et al.* (1987) reported that urethral obstruction induces post renal azotemia, electrolyte disturbances and acidosis.

Mc Loughlin (2000) stated that obstruction to urine outflow might cause varying degree of damage to the upper urinary tract and the degree of upper urinary tract injury and associated pathophysiology was based on a number of factors, including the chronicity and degree of obstruction and presence of urinary tract infection. Acute complete or severe partial urethral obstruction produced post renal azotemia that could be fatal within three to six days if not corrected.

Lipscomb (2003) reported that urinary tract obstruction resulted in progressively worsening dehydration, hypovolaemia, azotemia, metabolic acidosis, and hyperkalemia. In dogs with lower urinary tract obstructions, prolonged bladder distension resulted in bladder wall ischaemia and detrusor muscle atony.

2. 8. TREATMENT

2.8.1. Medical treatment

Ling and Gilmore (1977) observed that amoxycillin was effective against urinary tract infections caused by staphylococci and streptococci spp.

Osborne *et al.* (1981) managed struvite urolithiasis with acidification of urine, diuresis (by oral administration of 0.5 to 10 g sodium chloride/ day to stimulate thirst) urease inhibitor, acetohydroxamic acid at a dose rate of 100mg/kg/day divided in to two doses, modification of diet containing low concentration of phosphorous magnesium and high concentration of sodium chloride and by control of urinary tract infections.

Lewis and Morris (1984) reported that feeding a calculolytic diet resulted in phosphate urolith dissolution in two-20 weeks.

Ling (1984) described common isolates of canine urinary bacteria and there sensitive antimicrobial agent for each species. *Proteus mirabilis,* Steptococcus spp, Staphylococcus spp (Penicillin), Pseudomonas (tetracycline), *E.coli* and Enterobacter (Trimethoprim/ sulfonamide), Kebsiella spp (Cephalexin). The author also stated that entire population could acquire resistance by genetic transfer.

Sinha *et al.* (1986) stated that cystone therapy controlled the recurrence of urolith formation.

Lee and Rogers (1986) recommended that aminoglycoside drugs should not be used as a first choice for the treatment of urinary tract infections in dogs and cats because of potent nephrotoxicity.

Rubin (1990b) treated dogs with acute bacterial prostatitis with antibiotics on the basis of culture and sensitivity test of prostatic fluid collected from an ejaculate or

prostatic wash. If prostatic fluid not obtained, urine or urethral discharge could be cultured. In chronic prostatitis, antibiotics should be administered for at least one or two months. The dog with prostatic abscessation was treated by surgical drainage and anti microbial therapy.

Shaw (1990) reported flouroquinolone antibiotics had broad spectrum anti bacterial activity, prostatic tissue penetration and high urine concentrations.

Krawiec (1991) stated that in the treatment of bladder neoplasia, curative therapy was successful only if the tumour was benign. Palliative therapy consisted of combination of antibiotics to treat concomitant urinary tract infections, surgical removal, or debulking of the tumour, radiation therapy, intravesical and systemic chemotherapy and intravesical hypothermia.

Dowling (1996) used amoxycillin and cloxacillin for the treatment of urinary tract infections.

Ling (2000) reported that in uncomplicated cases of urinary tract infections, urine sample was cultured between 7^{th} and 10^{th} day of treatment. If growth was not observed, the treatment was considered to be successful and the antibiotic should continue for two week period. A follow up urine culture should be conducted on urine specimens obtained between one or two weeks after completion of the treatment and if this culture was negative, no further treatment was needed. If the growth was detected on seventh and 10^{th} day of treatment, then another antibiotic based on culture and sensitivity was administered and repeated the same procedure.

Brown (2002) reported that bethanechol was a cholinergic agent and enhanced detrusor contractions.

Damodaran (2004) reported that the cystone therapy controlled the recurrence of urolith formation.

According to Kutzler and Yeager (2005) used chloramphenicol and enrofloxacin for the treatment of prostatic diseases. The authors reported that both readily crossed the epithelial membrane of prostate gland, however ciprofloxacin did not penetrate the prostatic wall.

Prasad *et al.* (2007) reported that herbal drugs like cystone (Himalaya drug company, India), calcuri (Charak pharmaceuticals, Bombay, India) and Chandraprabha bati (Baidyanath, India) were widely used clinically to dissolve urinary calculi in the kidney and urinary bladder and these might helpful in decreasing the recurrence rate of calculi formation.

2.8.2. Surgical treatment

Hoff (1986) reported that surgical removal was required for oxalate calculi.

Mitra *et al.* (1989) described the treatment of urethral calculi in dogs by retrograde hydropropulsion and cystotomy.

Mohindra *et al.* (1996) stated that in dogs where urethral incisions were sutured, degree of inflammation and intensity of fibrosis were relatively less compared to non sutured urethral incision. No appreciable urethral stricture occurred in any of the dog.

Kyles and Stone (1998) reported that the urethrotomy incision healed completely in two to four weeks by second intention.

Ling *et al.* (1998b) suggested that surgical removal of calculi had been the principal treatment modality although medical dissolution of calculi, medical and dietary measures were recommended to prevent recurrence.

According to Bjorling (2002) healing of urethrotomy site was similar in both sutured and non sutured wounds and more haemorrhage observed when urethrotomy

wound was not sutured. The author also reported that no urethral stricture occurred in any of the dog when urethral incision was not sutured.

Lipscomb (2003) used a simple continuous non lumen penetrating, appositional suture followed by a second layer of an inverting, continuous Cushing suture pattern for cystotomy wound closure.

Damodaran (2004) reported in case of obstructive urolithiasis, surgical correction was effective, as it ensured immediate relief of obstruction and stress. Urethrotomy was found to be satisfactory in removing urethral calculi in male dogs and cystotomy was required to remove large calculi.

Dolinsek (2004) performed cystotomy for the removal of calcium oxalate cystic calculi.

Lipscomb (2004) reported post operative haemorrhage for up to two weeks and urine leakage as the major complications of urethrotomy especially in open urethrotomy wound.

2.8.3. Non surgical treatment

Osborne *et al.* (1983) described non surgical removal of uroliths from urethra of female dog by urohydropropulsion by injecting liberal quantity of 1:1 mixture of sterilized saline solution and aqueous lubricant through a flexible catheter.

Lewis and Morris (1984) reported the prevention of recurrence of struvite urolithiasis by antimicrobial therapy, administration of urease inhibitors, acidification of urine and induction of diuresis, dietary protein and mineral restriction for preventing recurrence.

Lulich *et al.* (1993) reported that voiding urohydropropulsion was a simple and effective method for removal of small uroliths from dogs and cats before cystotomy.

Bubenik *et al.* (2007) suggested that urinary tract catheterization was a reasonable alternative for management of dogs with urinary bladder dysfunction but duration of catheterization should be minimized and indiscriminate antimicrobial administration to dogs with indwelling urinary catheters should be avoided.

Materials and Methods

3. MATERIALS AND METHODS

3.1. SELECTION OF DOGS

The present study was conducted in 13 dogs of either sex, belonging to different breeds and age with the symptoms of lower urinary tract disorders presented at the Veterinary College Hospital, Mannuthy and University Veterinary Hospital, Kokkalai.

Of the thirteen dogs, six dogs were suffering from urolithiasis, five dogs were cystitis, one with bladder tumour and one with urinary incontinence due to prostatic abscess. The dogs were serially numberd as A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11, A12 and A13. Of the six dogs with urolithiasis, two dogs (A1 and A6) showed recurrence after 25 days and three months were numbered as A1 (R) and A6 (R) respectively and were studied as two separate clinical cases. Thus a total of 15 clinical cases in 13 dogs were utilized for the study.

3.2. INCIDENCE

Age, breed, sex and body weight of the dogs were recorded.

3.3. CLINICAL SIGNS AND DURATION OF ILLNESS

Clinical signs exhibited by the dogs and duration of illness were recorded.

3.4. RADIOGRAPHIC EVALUATION

3.4.1. Survey Radiography

All the dogs were subjected to survey radiography on the day of presentation. Lateral radiograph of abdomen including pelvis, perineal region and the course of

urethra were taken to locate the calculi and to identify the condition of the urinary bladder, urethra and prostate gland.

3.4.2. Contrast Radiography

The dogs in which survey radiography was not sufficient for diagnosis, contrast radiography of bladder and urethra was conducted. Sodium and meglumine salt of diatrizoate[1] was used as contrast medium. The dogs were sedated with atropine sulphate[2] and xylazine hydrochloride[3] at a dose rate of 0.045 mg/ kg body weight and one mg/kg body weight respectively.

Double contrast cystography was performed in dog A7. Catheterized the bladder, drained the urine and infused undiluted positive contrast medium five millilitre into the bladder. After shaking the dog sideways to ensure spread of contrast medium over the bladder mucosa, infused negative contrast medium (air) at a dose rate of 10 ml/ kg body weight. The radiograph of lateral view of the abdomen was taken (Park and Wrigley, 2002). The positive contrast cystogram was conducted in A13 and in one normal dog for comparison. The contrast medium was diluted to a 20% solution with physiological sterile saline and infused through the catheter at a dose rate of 10 ml/ kg body weight (Essman, 2005).

The negative contrast cystography was conducted by infusing the room air at a dose rate of 10 ml /kg body weight in one normal dog (Lavin, (1994) and Park and Wrigley, (2002)

The retrograde urethrogram was conducted in two dogs by infusing five milliliters of sodium and meglumine salt of diatrizoate through the catheter.

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1. Trazograf 76% - JB.Chemicals and Pharmaceuticals Ltd., Ankleshwar, India
2. Atropine Sulphate, (0.6 mg/ml)-Mount Mettur Pharmaceuticals Ltd.,India.
3. Xylaxin, (20 mg/ml) - Indian Immunologicals Ltd., Guntur

3.5. ULTRASONOGRAPHIC EVALUATION

Ultrasonographic evaluation was carried out in 10 dogs using "L & T symphony" and "HONDA H S 2000 VET ultrasound scanners" having 3.5, 5 and 7.5 MHz mechanical sector transducer in necessary cases.

3.6. MEDICAL MANAGEMENT

Dogs with cystitis were treated with antibiotics based on results of culture and sensitivity test of urine and urinary acidifiers/alkalinizers. In cystitis cases, the treatment was initiated with Ciprofloxacin[4] at the dose rate of 10 mg/ kg body weight orally for three consecutive days. On third day onwards, antibiotic was changed based on the result of culture and sensitivity test if needed and administration of the antibiotic was continued for seven days. If the microbial growth was not observed on seventh day, the same antibiotic was continued for two more weeks. If there was growth on seventh day, antibiotic was changed according to the results of culture and sensitivity for next seven days. Recultured the urine sample on 14th day and repeated the same procedure accordingly. (Ling., 2000).

In dog with cystitis and urinary incontinence treated with cholinergic agent bethanechol[5] 10mg was administered orally every eight hours to enhance bladder tone. The dog with prostatic abscess was treated with suitable antibiotic and bladder tumour case was treated with supportive therapy.

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4. Ciplox (250mg and 500mg) – Cipla Ltd, Malpur, Solan.
5. Bethacol (25mg) – S. G. Pharmaceuticals, Vadokara, India

3.7. SURGICAL MANAGEMENT

For urethral calculi, urethrotomy was performed just behind the level of os penis (prescrotal urethrotomy) in five cases. In the case with urethral and large cystic calculi, both urethrotomy and cystotomy were performed. In the dog with large cystic calculi, cystotomy was performed to remove the calculi.

3.7.1. Surgical site

For urethrotomy, the ventral aspect of prepucial region to the base of scrotum and for cystotomy, the caudal midventral abdominal region was shaved. Scrubbed the site with chlorhexidine-cetrimide antiseptic lotion[6], washed, mopped dry and applied Tr. Iodine.

3.7.2. Anaesthesia

All the dogs were administered with atropine sulphate at the dose rate of 0.045 mg/kg body weight intramuscularly as preanaesthestic. After fifteen minutes, xylazine hydrocholoride at the dose rate of one mg/kg body weight was administered intramuscularly to induce sedation. For urethrotomy, local infiltration anaesthesia was carried out at the proposed site of incision by infiltrating two millilitres of 2% lignocaine hydrochloride[7] solution. For cystotomy general anaesthesia with ketamine[8] at a dose rate of 10 mg/ kg body weight was also used.

3.6.3. Surgical Technique

3.6.3.1. Urethrotomy: The site of incision was prescrotal region along the mid line.

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6. Suphalon- Southern Union Pharmaceuticals (Kerala) Pvt Ltd., Thrissur
7. Xylocaine 2%,(30 ml vial)- Astra Zeneca Pharma India, Mumbai
8. Ketmin 50 (50 mg/ ml), 2 ml ampoule- Themis Medicare Ltd., Vapi, Gujarat

The dogs were controlled on dorsal recumbency. The surgical site was draped with sterile drapes and fixed with towel clip. A sterile metal probe lubricated with xylocaine gel[9] was inserted through the external urethral orifice up to the level of obstruction. By holding the penis firmly between the thumb and index finger, a two centimeter long skin incision was made on the midline. The subcutaneous tissue was incised, the paired retractor penis muscles were identified and retracted laterally on either side.

The urethra was exposed and incised along its mid line. The calculi near the incision site were removed one by one with the help of artery forceps and in one case the calculi at the site of the incision were expelled while incising the urethra along with urine spurted out. The calculi lodged within the groove of os penis were gently dislodged by passing a lubricated sterile metal probe through the external urethral orifice and pushing towards the incision. Some of the calculi lodged in the urethra, anterior and posterior side of the incision, were removed by means of a mosquito forceps inserted through the urethral incision. Urine samples were collected in sterile vials for cultural examination and for analysis. A sterile infant feeding tube of suitable size was inserted through the external urethral orifice and urethra was flushed with normal saline to dislodge the calculi. Gentle compression of the bladder at the vertex over the abdominal wall facilitated expulsion of the calculi along with the urine through the wound. In cases where it was not possible to remove, flushing of the urethra through the catheter with normal saline was carried out to dislodge the calculi.

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9. Xylocaine jelly 2%, (30 g)- Astra Zeneca Pharma India., Mumbai

In all the dogs the calculi lodged in the course of urethra were removed completely. After establishing the patency of the urethra, bladder was flushed with sterile normal saline through the catheter to remove calculi, epithelial casts and debri. Bleeding from the urethra was controlled by instilling sterile haemocoagulase solution[10]. Simple interrupted suture with braided silk 1/0 was applied on either side of incision to reduce the size of the wound. The urethral incision was left open.

The catheter was introduced into the bladder through the normal external urethral orifice and was fixed to the prepucial skin by simple interrupted suture using braided silk 1/0. The wound was daily dressed with framycetin[11] ointment.

3.6.3.2. Cystotomy: In two dogs cystotomy was performed. For cystotomy, a six centimeter long skin incision was put on the mid ventral region starting from behind the umbilicus and extended caudally lateral to the prepuce. The penis along with its sheath was displaced laterally to expose the linea alba. The linea alba was incised to reach the abdominal cavity. Exteriorized the urinary bladder and packed with sterile towel. Put a nick incision on the dorsal aspect on most avascular area and a catheter was introduced and evacuated the urine through the catheter. The nick incision made was enlarged by incising on either side. The calculi were visible through the incision and were removed by forceps. After the removal of the calculi, the bladder was thoroughly explored to detect and to remove any remaining calculi. Flushing of the bladder was carried out with sterile normal solution and a catheter was introduced through the bladder into the urethra and other end was taken out through external urethral orifice and fixed in position. The cystotomy wound was closed by double

10. Botroclot-Topical solution 0.2ml, JuggatPharma, Banglore

11. Soframycin skin cream – Aventis Pharma Ltd., Goa.

layer inversion sutures, Cushing followed by continuous Lembert using chromic catgut No.2/0. A catheter was introduced through the external urethral orifice and fixed at the prepucial skin. The peritoneum along with linea alba was sutured using chromic catgut No. 1/0 and the sheath was repositioned and sutured using subcuticular suture. The skin wound was closed by vertical mattress suture using monofilament nylon.

3.7.4. Findings during surgery

The condition of the urinary bladder, presence of calculi/ lesions were recorded. The difficulties encountered if any during surgery for the removal of calculi or for passing and fixing of catheter after surgery and bleeding from the wound were recorded. From all the dogs urine samples were collected during surgery in sterile vials. The pH, colour and consistency of the urine samples were immediately noted and were subjected for culture and sensitivity test and analysis. The calculi removed were examined for its size, shape and the number and observations were recorded. Calculi retrieved from the dogs were subjected to chemical analysis for composition.

3.7.5. Postoperative Management

The catheter introduced was fixed to the prepucial skin by simple interrupted suture to the prepucial skin so as to keep it *in situ*. The skin wound was painted with Tr. Benzoin. The wound was daily dressed with framycetin skin cream. To all the dogs, Lactated Ringer's solution[12] at the dose rate of 10ml/kg body weight was administered intravenously.

12.Ringer Lactate (540 ml)-Parentral Drugs Ltd.,Indore, Madhya Pradesh

Amoxycillin-Cloxacillin[13] was administered intramuscularly at the dose rate of 10mg/kg body weight on the day of surgery and tablets of amoxycillin-cloxacillin[14] at the dose rate of 10mg/kg body weight three times daily orally for the second day. On third day onwards, specific antibiotics were administered based on the results of culture and sensitivity tests of the urine collected and administration of antibiotic was continued for seven days. Even if no growth could be detected on seventh day, then also the same antibiotic was continued for two more weeks. Appropriate medication for alkalanization of the urine was recommended. For alkalanization, disodium hydrogen citrate[15] one teaspoon twice daily for two weeks and also cystone[16] one tablet thrice daily were administered for three months. The owners were advised to give adequate water for drinking and to reduce the protein content of solid food by reducing the quantum of meat, fish, and egg from the routine diet in case of urolithiasis. After surgery, retention of the catheter (catheter tolerance), healing of surgical wound and complications if any, were recorded.

3.7.6. Catheter tolerance

Catheter tolerance was observed for six days postoperatively in all the dogs subjected to surgical treatment.

3.7.7. Healing of the surgical wound

Healing of the surgical wound was observed for 21 days postoperatively in all cases with urolithiasis.

13.Intamox (500 mg injection)-Intas Pharmaceuticals Ltd.,Matoda, Ahmedabad
14.Novaclox (amoxycillin 250 mg, Cloxacillin 250 mg)- Oksa Pvt. Ltd., Goa.
15.Citralka, (1.5 mg/5 ml)- Park Davis Ltd., Mumbai, Maharashtra
16.Cystone, Herbal Product- Himalaya Ltd., Makali, Bangalore

3.8. RECURRENCE OF UROLITHIASIS

After surgical removal of the calculi, the dogs were enquired (by telephone) for a maximum of one year for recurrence if any.

3.9. MAIN ITEMS OF OBSERVATION

3.9.1. Signalment and anamnesis

The symptoms noticed by the owner, duration of illness and details of previous medications were recorded.

3.9.2. Clinical examination

All the dogs were subjected to detailed clinical examination on the day of presentation, seventh and 21st day of surgery.

3.9.2.1. General condition: The general conditions of all the dogs were assessed as active, dull and weak.

3.9.2.2. Feeding and voiding habits: In all the dogs, the type of diets (vegetarian or non vegetarian) fed and difficulty in urination or defaecation were recorded.

3.9.2.3. Palpable signs: Palpable signs like distension of the urinary bladder, pain noticed on palpation and fluid thrills if any were recorded.

3.9.3. Physiological parameters

Respiraton rate (per minute), pulse rate (per minute), rectal temperature (°C), and colour of visible mucous membranes were recorded.

3.9.4. Catheterization

The dogs with difficulty in urination were subjected to catheterization. Catheterization was carried out to locate the site of obstruction in cases with urolithiasis, to relieve urine in cases where there was no urethral obstruction and also to collect urine for culture and sensitivity test. Sterile infant feeding tubes[17] of sizes ranging from 6 FG to 10 FG were used for catheterization according to size of dogs. The catheter was lubricated with lignocaine hydrochloride gel and was introduced through external urethral orifice

3.9.5. Urinalysis

Urine samples were collected from all the dogs in sterile vials by catheterization on day first, seventh and 21st for physical, chemical and microscopic examination of urine.

3.9.5.1. Physical examination of urine: The urine samples collected in transparent vials were examined for colour, transparency, pH and specific gravity using uristick[18]on the day of presentation, seventh and 21st day.

3.9.5.2. Chemical examination of urine: Urine samples were analysed for protein, glucose, ketone bodies, bile pigments and bile salts using uristick on the day of presentation, seventh and 21st day.

3.9.5.3. Microscopic examination: Sediments of the urine samples were examined for the presence of crystals, casts, epithelial cells, WBC and RBC. The urine samples were mixed well and poured in test tube and centrifuged at 3000 rpm for three minutes. The supernatant was discarded. Sediment was transferred to a slide and

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18. Uristick - DIRUI Industrial Co., Ltd., Chagchun, China

17.Infant feeding tube- Romsons Sci.& Surg. India (P) Ltd.,Agra

examined under microscope (low and high power) and later it was stained with Leishman stain for the identification of crystals, microorganisms and epithelial cells (Benjamin, 2005). The shapes of commonly occurring crystals were studied and recorded.

3.9.6. Culture and sensitivity test of urine sample

Urine samples were collected in sterile vials and a loopful of urine was inoculated in Brain Heart Infusion Agar plate using quadrant streaking method. All the plates were incubated in air at 37^0C for 24 hours and examined for the presence of bacterial growth, if any. Sensitivity of the urine samples were carried out as per the method of Quinn *et al.* (2002).

3.9.7. Prostate fluid analysis

In one case with prostatic abscess, the prostate gland was massaged per rectum and the urethral discharge collected was stained and observed under microscope.

3.9.8. Hematological Parameters

Blood samples were collected from cephalic vein/ saphenous vein with EDTA at the rate of one mg/ml as anticoagulant (Ethylene Diamine Tetra Acetic acid) on day first, seventh and 21^{st} for haematological evaluation which included total erythrocyte count, total leucocyte count (TLC), haemoglobin concentration (Hb) and volume of packed red cells (VPRC). Blood smear without EDTA was prepared for differential leucocytes count (DLC) (Benjamin, 2005).

3.9.9. Biochemical Parameters

Blood samples without anticoagulant were collected and separated serum for analyzing biochemical constituents on day first, seventh and 21^{st}. Blood urea nitrogen (BUN), Creatinine, total protein and albumin were estimated by using

standard Agappe Diagnostic kits[19]. Globulin concentration was obtained by deducting albumin concentration from total protein. Sodium (Na^+) and Potassium (K^+) were analyzed by flame photometry.

3.9.10. Out come of treatment

The out come of medical or surgical management were noted in all cases. In case of surgical management, surgical recovery and healing of surgical wounds were also recorded.

3.9.11. Calculi analysis

3.9.11.1. Morphological appearance of calculi: The morphological appearance like colour, surface characteristics and shape were assessed according to Weichselbaum *et al.* (1998).

3.9.11.2. Qualitative Analysis: The mineral analysis of the calculi was done as per standard qualitative method (Varley, 1981).

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19. Agappe Diagnostics, Thana, Maharashtra

Fig. 1. Contrast medium used for the study

Fig. 2. Quick check multiscreen dipstick (uristick) for urinalysis

Results

4. RESULT

4.1. SELECTION OF DOGS

The present study was conducted as 15 cases in 13 dogs presented at the the Veterinary College Hospital, Mannuthy and University Veterinary Hospital, Kokkalai with the symptoms of lower urinary tract disorders.

Among the 13 dogs studied, six had urolithiasis, (A1, A2, A3, A4, A5, and A6), five had cystitis (A7, A8, A9, A10 and A11), one case was urinary incontinence due to prostatic abscess (A12) and one bladder tumour (A13). Of the six dogs with urolithiasis, two dogs (A1 and A6) showed recurrence after 25 days and three months were numbered as A1 (R) and A6 (R) respectively and were studied as two separate clinical cases. Thus a total of 15 clinical cases in 13 dogs were utilized for the study.

4.2. INCIDENCE (Table 1)

4.2.1. Age

The average age of incidence of urolithiasis was seven years and cystitis was 6.8 years. In case of cystitis, the average age of incidence in male was eight years and in female was five years. The age of incidence of prostatic abscess was nine years and bladder tumour was 10 years.

4.2.2. Breed

Out of six dogs affected with urolithiasis two were Dachshunds, one each was Labrador, Spitz, Boxer and Samoyed. Out of five dogs affected with cystitis, two were Dachshunds, and one each was Labrador, Rottweiler and German shepherd. The dog affected with prostatic abscess was a German Shepherd dog (GSD) and bladder tumour was Cocker Spaniel.

Table 1. Observations on age, breed, sex, body weight, duration of illness and clinical condition of the dogs under study

Sl. No.	Dog No.	Age (years)	Breed	Sex	Body weight (kg)	Duration of illness	Condition diagnosed
1	A1	3½	Labrador	Male	40	2 days	Urolithiasis
2	A1 (R)	3½	Labrador	Male	40	2 days	Urolithiasis
3	A2	7	Spitz	Male	10	2 weeks	Urolithiasis
4	A3	10	Dachshund	Male	12	2 days	Urolithiasis
5	A4	10	Samoyed	Male	15	1 week	Urolithiasis
6	A5	3	Boxer	Male	15	1 week	Urolithiasis
7	A6	10	Dachshund	Male	12	1 month	Urolithiasis
8	A6(R)	10	Dachshund	Male	12	1 week	Urolithiasis
9	A7	7	Labrador	Male	30	1 week	Cystitis
10	A8	5	Rottweiler	Female	35	6 days	Cystitis
11	A9	7	Dachshund	Male	7.5	2 days	Cystitis
12	A10	10	Dachshund	Male	12	2 days	Cystitis
13	A11	5	GSD	Female	40	1 week	Cystitis
14	A12	9	GSD	Male	40	1 week	Prostatic abscess
15	A13	10	Cocker Spaniel	Male	10	1 week	Bladder tumour

4.2.3. Sex

All the dogs affected with urolithiasis were males and all were sexually intact except A5. Out of five dogs affected with cystitis three were males and two were females. The dog affected with bladder tumour was a male.

4.2.4. Body weight

The dogs were weighed between 7.5 and 40 kg.

4.3. CLINICAL SIGNS AND DURATION OF ILLNESS

The clinical signs (Table 2) exhibited were reduced food and water intake in all dogs except A7. All the dogs showed difficulty in urination (dribbling) except three dogs (A7, A8 and A9) and bladder distension was detected in all dogs except in two (A8 and A9). Vomiting was showed by five dogs (A1, A1(R), A2, A11 and A13) and haematuria by seven dogs (A1, A7, A8, A9, A10, A12 and A13). In dog A1, palpation of penile urethra revealed hard mass behind the level of os penis suggestive of obstruction with calculi. In dog A12, rectal palpation revealed prostatic enlargement and other clinical signs like dyschezia, fever, urethral discharge and caudal abdominal pain were also present. In dog A13, bleeding from gum and petechiae over the skin of lower abdomen, tip of penis and gum were noticed. In dog A8, blood in last part of urine was observed.

The dog A10 with cystitis was not able to bear weight on hind limb, pedal reflex, patellar reflex and proprioception were absent on pelvic limbs.

The duration of illness (Table 1) of dogs with urolithiasis was varied from two days to one month and that of cystitis was two days to one week. The duration of illness of prostatic abscess and bladder tumour were one week.

Table 2. Obsevations on clinical signs exhibited by the dogs under study.

Sl. No.	Dog No.	General condition	Colour of mucous membrane	Food intake	Vomiting	Urination	Haematuria	Condition of bladder
1	A1	Dull and lethargic	Congested	Reduced	Present	Dribbling	Present	Distended
2	A1(R)	Dull and lethargic	Congested	Reduced	Present	Dribbling	Absent	Distended
3	A2	Dull and lethargic	Congested	Reduced	Present	Dribbling	Absent	Distended
4	A3	Dull and lethargic	Congested	Reduced	Absent	Dribbling	Absent	Distended
5	A4	Dull and lethargic	Congested	Reduced	Absent	Dribbling	Absent	Distended
6	A5	Dull and lethargic	Congested	Reduced	Absent	Dribbling	Absent	Distended
7	A6	Dull and lethargic	Congested	Reduced	Absent	Dribbling	Absent	Distended
8	A6(R)	Dull and lethargic	Congested	Reduced	Absent	Dribbling	Absent	Distended
9	A7	Active	Pale roseate	Normal	Absent	Normal	Present	Distended
10	A8	Active	Congested	Reduced	Absent	Normal	Present	Normal
11	A9	Active	Congested	Reduced	Absent	Normal	Present	Normal
12	A10	Weak and recumbent	Congested	Reduced	Absent	Dribbling	Present	Distended
13	A11	Dull and lethargic	Congested	Reduced	Present	Dribbling	Absent	Distended
14	A12	Weak and recumbent	Pale	Reduced	Absent	Dribbling	Present	Distended
15	A13	Weak and recumbent	Congested	Reduced	Present	Dribbling	Present	Distended

4.4. RADIOGRAPHIC EVALUATION (Table 3)

4.4.1. Survey Radiography

Lateral radiograph of abdomen revealed distension of bladder in all dogs except in A9. In dogs with urolithiasis, out of eight cases, including two recurrences, the survey radiography revealed the calculi were in the ventral groove of os penis in three cases (A2, A3 and A6) posterior to the os penis in one case (A4), ischial arch of the urethra in one case (A1(R). The urinary calculi with in the urinary bladder were detected in three cases (A1(R), A3 and A6) and in A9 tiny cystic calculi in one case. In dog A3 along with urethral and cystic calculi, prostate enlargement was also noticed. Survey radiography was not conducted in dog A1 where a calculus was located in the groove of os penis (confirmed during surgery).

In dogs with cystitis, distension of the urinary bladder and thickening of the bladder wall was noticed in A7. In dog A7, increased radioopacity and enlargement of kidney were also detected.

In A9, small sized ratio opaque calculi with in the urinary bladder were noticed. In A10, calcification and protrusion of the disc between sixth and seventh lumbar vertebrae and varying degree of calcification noticed in the second, third, fourth and fifth lumbar intervertebral space. In dog A11, bridging of ventral vertebral bodies of fifth and sixth lumbar vertebrae.

4.4.2. Contrast radiography

Double contrast cystography was performed in dog A7 revealed intraluminal filling defect within the bladder lumen. In dog A5, on survey radiography, no radioopaque calculi were detected. On positive contrast urethrography, migration of contrast medium up to the level of os penis was observed indicating obstruction at the level of os penis and during surgery confirmed the presence of calculi with in the

groove of os penis. In dog A6 (R) also positive contrast urethrography was conducted and narrowing of urethral lumen behind the os penis was detected indicating calculi behind the os penis. (confirmed during surgery). In dog A13, on positive contrast cystography, intraluminal radiolucent filling defect within the bladder lumen was observed.

4.5. ULTRASONOGRAPHIC EVALUATION (Table 3)

Ultrasonographic evaluation was conducted in 10 cases. Distended bladder was noticed in A1 (R), A4, A5, A6, A7, A8, A10, A11 and A13. In dogs A_1 (R) and A6, hyperechoic mass with acoustic shadowing was detected in bladder lumen indicating cystic calculi.

In dogs A7, A8 and A10, hyperechoic diffuse bladder wall thickening indicating cystitis were noticed and in dogs A7 and A10, moving hyperechoic masses without acoustic shadowing was also noticed which indicated the presence of intraluminal blood clot. In dog A12, irregular both hyperechoic and hypoechoic areas in the enlarged prostate gland indicating prostatic abscess.

In dog A13, hyperechoic intraluminal mass was detected indicating a space occupying lesion with in the bladder.

4.6. MEDICAL MANAGEMENT

The urine samples were taken from all cases for culture and sensitivity test. The treatment of cystitis was initiated with Ciprofloxacin at the dose rate of 10 mg/kg body weight orally twice daily for three consecutive days and on third day onwards, the same antibiotic was found to be sensitive as per the culture and sensitivity test in all dogs. The administration was continued for seven days. In dogs A9, A10 and A11, ciprofloxacin at the dose rate of 10 mg/kg orally twice daily

Table 3. Observations on radiographic and ultrasonographic findings and diagnosis arrived.

Dog No.	Radiographic Findings	Ultrasonographic Findings	Diagnosis
A1	Not conducted	Not conducted	Obstruction due to Urethral calculi (Confirmed by palpation of urethra)
A1 (R)	Radioopaque cystic calculi and a calculus in the urethra at the level of ischial arch and distension of the bladder.	Hyper echoic mass with in the bladder lumen casts acoustic shadowing and distended bladder	Obstruction due to cystic calculi and urethral calculi
A2	Radioopaque urethral calculi at the groove of the os penis and distension of the bladder	Not conducted	Obstruction due to Urethral calculi
A3	Radioopaque small cystic calculi and urethral calculi in the groove of os penis distension of the bladder and enlargement of prostate gland.	Not conducted	Obstruction due to Urethral calculi
A4	Urethral calculi behind the os penis and distension of the urinary bladder	The bladder was distended	Obstruction due to Urethral calculi behind the level of os penis
A5	Survey radiography – No radioopaque calculi with in the bladder and urethra,distended bladder. Contrast urethrography – Migration of contrast medium up to the level of os penis	Distended bladder	Obstruction due to Urethral calculi (Confirmed on surgery)
A6	Radio opaque small cystic calculi and urethral calculi in the groove of os penis and distension of urinary bladder	Hyperechoic foci with in the bladder lumen casts acoustic shadowing and distended bladder	Obstruction due to Urethral calculi
A6 (R)	Survey radiography – No radio opaque calculi and distension of urinary bladder. Contrast urethrography – Narrowing of urethra behind the level of os penis	Not conducted	Obstruction due to Urethral calculi (Confirmed on surgery)

Table 3. Continued. Observations on radiographic and ultrasonographic findings and diagnosis arrived.

Dog no	Radiographic findings	Ultrasonographic findings	Diagnosis
A7	Thickening of bladder wall, distended bladder and increased opacity and enlargement of the kidney. Double contrast cystography – intraluminal filling defect with in the bladder lumen	Irregular diffuse bladder wall thickening, large hyperechoic moving mass detected. Both kidneys were enlarged and in left kidney small nephroliths were detected	Chronic cystitis
A8	Distension of the urinary bladder was noticed.	Diffuse hyperechoic thickening of bladder wall and distended bladder	Cystitis
A9	Small sized cystic calculi	Not conducted	Cystitis due to cystic calculi
A10	Calcification and protrusion of the disc between 6^{th} and 7^{th} lumbar vertebrae and varying degree of calcification in the second, third, fourth and fifth lumbar intervertebral space and distended bladder.	Diffuse bladder wall thickening, large hyperechoic moving mass detected and distended bladder	Cystitis
A11	Bridging of the ventral vertebral bodies of fifth and sixth lumbar vertebrae and distended urinary bladder	Distended bladder	Cystitis, atony of bladder
A12	No radioopaque enlargement of prostate gland and distended urinary bladder	Irregular both hypoechoic and hyperoechoic area in the enlarged prostate gland	Prostatic abscess
A13	Survey radiography- Distended urinary bladder.Positive contrast cystography – Intraluminal radiolucent filling defect within the bladder lumen	Hyperechoic mass detected within the bladder and distended bladder	Tumour within the bladder lumen

for seven days was found to be effective and no growth could be detected on seventh day and advised to continue the antibiotics for two more weeks.

In all cases of cystitis, the organism isolated was *Escherichia coli*.

In dog A7, after treatment with ciprofloxacin even though the colony count was reduced from more than one lakh colony forming unit/ milliliter to more than 50,000 colony forming unit/ milliliter but the infection was not completely cured and thus the antibiotic was changed to gatifloxacin (400 mg)[1] once daily for seven days according to culture and sensitivity test. Thereafter the dog responded readily to treatment and no growth could be detected on 14th day and advised to continue the same antibiotic for two more weeks. In dog A8 after treatment with ciprofloxacin at the dose rate of 10 mg/kg body weight for seven days the colony count remains unchanged (more than one lakh colony forming unit/ milliliter) and administered norfloxacin[2] at the dose rate of 22mg/ kg twice daily for seven days according to culture and sensitivity tests. On reculturing the urine on next seventh day revealed reduction in colony count to more than 50,000 colony forming unit/ milliliter and gatifloxacin (400 mg) one tab once daily was prescribed for next seven days. There after the urine sample showed no growth on subsequent culture and advised to continue the same antibiotic for two more weeks. In dog A9 with cystitis, small sized radio opaque cystic calculi and in A7 small nephrolith were detected. In these cases, apart from antibiotics and urinary alkalanizer, advised cystone one tablet thrice daily for three months. In dog A11, urinary incontinence still persisted even after curing the cystitis. So to enhance bladder tone bethanechol 10 mg orally every eight hours was given for one month. But only slight improvement was there as reported by the owner. Urinary alkalanizer viz. disodium hydrogen citrate was given orally at the dose rate of one teaspoon twice daily for two weeks in all dogs.

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[1] Gatiquin - 400 (Gatifloxacin-400 mg), Cipla Ltd.,Mlpur, India

[2] Norflox – 400mg (Norfloxacin and Lactic acid bacillus), Okasa Pvt. Ltd., Malpur

In dog A12, on culture and sensitivity test revealed *E.coli* and the colony count was more than one lakh colony forming unit/ml and the sensitive antibiotics were ciprofloxacin, enrofloxacin, gatifloxacin, ofloxacin and cefotaxim. Enrofloxacin[3] at the dose rate of 5mg/kg body weight was administered intramuscularly for seven days but not responded to the treatment. The urine culture on day seventh revealed the same organism and colony count was also same and the sensitive antibiotics were gatifloxacin, pefloxacin and cefotaxim and administered gatifloxacin (400mg) orally once daily but the dog died on 11th day. The dog A13 with bladder tumour, the organism isolated was Staphylococcus and the colony count was more than one lakh colony forming unit/milliliter and the sensitive antibiotics were ciprofloxacin, amoxycillin, enrofloxacin and gatifloxacin. The dog developed renal failure and had treated with Normal saline[4], dextrose 25 %[5] each 50 ml and amoxycillin-cloxacillin at the dose rate of 10 mg/kg body weight intravenously as supportive therapy for four days but it died on fifth day.

4.7. SURGICAL MANAGEMENT

4.7.1. Surgical site

The site of incision was prescrotal site caudal to the prepuce just cranial to the scrotum along the mid line for urethrotomy and for cystotomy mid ventral region starting from behind the umbilicus and extended caudally lateral to the prepuce were found to be enough for removal of both cystic and urethral calculi behind os penis and on ventral groove of os penis.

[3] Enrofloxacin injection (Enrofloxacin 10%), Alps Pharmaceuticals (P), Ltd., Almora
[4] Normal saline (Sodium chloride injection, 0.9per cent. W/V)-Goa formulation Ltd.,Goa
[5] Dextrose 25 per cent (D25) - Beryl drugs, Ltd., Dhar, U.P.

4.7.2. Anaesthesia

The anaesthesia using atropine sulphate at the dose rate of 0.045 mg/ kg body weight as preanaesthetic, xylazine at the dose rate of one mg/kg body weight for induction of sedation and local infiltration anaesthesia at the site of surgery using two per cent xylocaine was found to be satisfactory in all dogs undergone urethrotomy. In cystotomy, general anaesthesia with ketamine at dose of 10 mg/kg body weight was administered and the muscle relaxation and anaesthesia was found to be satisfactory.

4.7.3. Surgical technique (Table 4)

4.7.3.1. Urethrotomy: Urethrotomy was performed just behind the level of os penis (prescrotal urethrotomy) in five cases (A1, A2, A3, A4 and A5). In dog A6 with both urethral and cystic calculi, urethrotomy was performed along with cystotomy. In dog A6, recurrence of the calculi was observed after three months and was subjected to urethrotomy again. A two centimetre long incision on the skin was found to be sufficient in all the dogs. In dogs A1 and A3, a single calculus was lodged with in the ventral groove of os penis was gently dislodged by passing a lubricated metal probe through the external urethral orifice and pushed towards the incision and were removed with mosquito forceps. In dog A2, few calculi at the site of incision were expelled along with the urine spurts while incising the urethra and few calculi were at anterior and posterior to site of incision were removed with mosquito forceps and few were lodged with in the groove of os penis were gently dislodged by passing a lubricated metal probe through the external urethral orifice and pushed towards the incision and were removed with mosquito forceps. In dogs A4 and A6 (R), the calculi were located behind the os penis were removed with mosquito forceps. In dogs A4 and A6, the calculi were in the groove and were removed with mosquito forceps. Flushing of the urethra through the catheter with normal saline was carried out in all dogs to dislodge the calculi. The urethral opening was widened by

Table 4. Observations on location of calculi, operation performed and recurrence after treatment.

Sl. No.	Dog No.	Location of calculi				Operation Performed	Recurrence after treatment
		Groove of os penis	Posterior to os penis	Pelvic urethra at the level of ischial arch	Urinary Bladder		
1	A1	+	-	-		Prescrotal urethrotomy	Recurrence after 25 days
2	A1 (R)	-	-	+	+	Cystotomy	Nil
3	A2	+	-	-	-	Prescrotal urethrotomy	Nil
4	A3	+	-	-	+	Prescrotal urethrotomy	Nil
5	A4	-	+	-	-	Prescrotal urethrotomy	Nil
6	A5	+	-	-	-	Prescrotal urethrotomy	Nil
7	A6	+	-	-	+	Prescrotal urethrotomy and cystotomy	Recurrence after three months
8	A6(R)	-	+	-	-	Prescrotal urethrotomy	Nil

+ - Present

- - Absent

introducing a mosquito forceps and gentle compression of the bladder towards the vertex to evacuate the urine and the small calculi present in the bladder. This helped to dislodge the calculi in most of the cases and calculi were flushed along with the urine. Established the patency of the urethra by introducing catheter from the site of incision to bladder and flushed with sterile normal saline through the catheter was also carried out.

4.7.3.2. Cystotomy: Cystotomy was performed in two dogs (A6 and in A1 (R)). In A1 (R) with recurrence the calculi was noticed after 25 days and in that case a calculus was lodged in pelvic urethra at the level of ischial arch was removed by retrohydropropulsion into the urinary bladder and thereafter cystotomy was performed and removed the calculi. The incisional wound at linea alba was sufficient to exteriorize the bladder. The drainage of the urine through the nick incision and introduction of sterile catheter was sufficient to drain the urine without contamination of abdominal cavity. Cystotomy wound was sufficient to remove the calculi and favoured for flushing the bladder and urethra to establish the patency.

4.7.4. Findings during surgery

The calculi lodged at the site of incision and posterior to os penis of urethra could be easily removed by mosquito forceps (A2, A4 and A6(R)). In a case calculi expelled along with the urine spurted out (A2). Those calculi which were lodged in the groove of os penis could be removed by introducing the metal probe through the external urethral orifice and flushing normal saline and dislodged the calculi (A1, A2 and A3). The flushing of the penile portion of urethra with sterile normal saline favoured dislodgement of calculi. The calculi were in the groove were also removed with mosquito forceps in two dogs (A5 and A6).

The gentle compression of the urinary bladder was carried out which facilitated the evacuation of the urine and expulsion of small calculi present in the bladder.

Patency of the urethra was established by introducing catheter from the incision site towards the bladder. A catheter lubricated with lignocaine gel was introduced in to the bladder through the external urethral orifice and fixed *in situ.*

In all dogs, haemocoagulase solution was instilled in to the site and controlled the bleeding.

Cystotomy was performed to remove the cystic calculi in two dogs (A1(R) and A6. In dog A1(R), the urethral calculi at the level of ischial arch was removed by retrohydropropulsion into the bladder and cystotomy was performed. A sterile catheter was introduced into the bladder through the external urethral orifice and was fixed in position.

In one dog (A1 (R)), during surgery observed that the bladder mucosa was inflamed and increased thickening of the bladder wall.

In all the cases, blockage in the urethra could be relieved by surgery and catheterization through the external urethral orifice was feasible.

4.7.5. Postoperative management

Immediately after removal of calculi and establishment of the patency of urethra, Lactated Ringer's solution at the dose rate of 10ml/kg body weight administered intravenously for all dogs which helped to improve the general condition of dogs and favoured urine out put.

All the dogs were administered with amoxycillin – cloxacillin injection at the dose rate of 10 mg/kg body weight intramuscularly on the day of surgery followed by

oral administration at the dose rate of 10mg/kg body weight three times daily for three days. Thereafter specific antibiotics were administered on third day onwards based on the result of culture and sensitivity test of the urine collected. In dog A1(R) amoxycillin – cloxacillin was found to be effective. Ciprofloxacin at the dose rate of 10 mg/kg body weight twice daily orally for seven days was administered in five cases (A1, A2, A3, A4, and A6 (R). In two cases (A5 and A6) where the urine culture on the day of surgery revealed no growth was administered with amoxycillin–cloxacillin. In all cases, no growth of microorganisms on seventh day and advised to continue the same antibiotic for two more weeks.

For alkalanization, di sodium hydrogen citrate one teaspoon twice daily for two weeks and cystone one tablet thrice daily were administered for three month. The wound was daily dressed with framycetin skin cream and the ointment was tolerated by all dogs. Advised the owners to give adequate water for drinking and to reduce the protein content of solid food by reducing the quantum of meat, fish, and egg from the routine diet in case of urolithiasis.

4.7.6. Catheter tolerance

Catheter tolerance was poor in all dogs except in dog A3. Catheter was removed on the same day itself by all dogs and in dog A3, the catheter was retained and it was removed on the sixth day.

4.7.7. Healing of the surgical wound

Healing of the surgical wound was good in all dogs. The leakage of urine and occasional bleeding through the urethrotomy wound was observed up to six days in all dogs and there after healed uneventfully. Swelling and slight oozing around the surgical site of cystotomy was noticed in dog A6. In all dogs, the healing was complete when it was observed on 21st day.

4.8. RECURRENCE OF UROLITHIASIS (Table 4)

In all cases improvement in condition was reported during the observation period. But on stoppage of medicine, recurrence of difficulty in urination was reported in two dogs, one on 25th day (A1 (R)) and the other after three months (A6 (R)). In A1 (R), the calculi were noticed in the urinary bladder and one calculus at the level of ischial arch. In the other dog obstruction was behind the os penis. Both dogs were subjected to surgery later.

4.9. MAIN ITEMS OF OBSERVATION

4.9.1. Signalment and anamnesis

Among the dogs with urolithiasis, two had previous history of partial or complete urinary obstruction (A1 and A6). Both of them subjected to retrohydropropulsion four months and one week back. Dog A3 with urolithiasis had cystitis three months back. Three dogs in the study were brought from the neighbouring state where there is more hard water consumption.

4.9.2. Clinical examination

All the dogs were subjected to detailed clinical examination on day of presentation, seventh and 21st days. Two dogs A12 and A13 were died on 11th and fifth day of treatment respectively. The two dogs (A2 and A5) were not presented on seventh and 21st days for review and on telephonic consultation the owners reported that the dogs were normal.

4.9.2.1. General condition: At the time of presentation, the general condition of all dogs with urolithiasis was dull and lethargic. Among five dogs with cystitis, three dogs were active (A7, A8 and A9), one was dull and lethargic (A11) and one was weak and recumbent (A10). The dogs A12 and A13 suffering from prostatic abscess

and bladder tumour were weak and recumbent. After treatment all the dogs were found to be active except two cases (A12 and A13), which were died on 11th and fifth day respectively.

4.9.2.2. Feeding and voiding habits: All the dogs with urolithiasis were fed with more nonvegetarian diet regularly composed of meat, fish, and egg. All the dogs in the study except three (A7, A8, and A9) showed difficulty in urination (dribbling). After surgical treatment in urolithiasis cases, owners were advised to reduce the protein content of solid food by reducing the quantum of meat, fish, and egg from the routine diet to prevent recurrence. In all the dogs, except in A11 the micturition was normal and in that case urinary incontinence was still persisted after treatment.

4.9.2.3. Palpable signs: Bladder distension was palpable in all dogs except in two (A8 and A9) and elicited pain on palpation of the urinary bladder by all dogs. In dog A13, a hard mass palpable within the urinary bladder. No fluid thrill was detected in any of the dogs. In dog A12, rectal palpation revealed prostatic enlargement. After treatment there was no distension of urinary bladder in all dogs except in A11 where there was moderate distension noticed on seventh and 21st day.

4.9.3. Physiological parameters (Table 5)

4.9.3.1. Rectal Temperature: In dogs with urolithiasis; the mean rectal temperature (^{0}C) before surgery was 39.05 ± 0.16. It was 38.88 ± 0.12 and 38.82 ± 0.20 respectively on seventh and 21st post operative days.

In dogs with cystitis, the rectal temperature (^{0}C) before treatment (on first day) was 39.25 ± 0.20. It was 38.76 ± 0.20 and 38.68 ± 0.25 respectively on seventh and 21st day.

Table 5. Observations on physiological parameters of the dogs with urolithiasis, cystitis, prostatic abscess and bladder tumour.

Physiological parameters	Urolithiasis (Mean ± S.E.) n=6			Cystitis (Mean ± S.E.) n=5			Prostatic abscess			Bladder tumour		
	1st day	7th day	21st day	1st day	7th day	21st day	1st day	7th day	21st day	1st day	7th day	21st day
Rectal temperature (°C)	39.05 ±0.16	38.88 ±0.12	38.82 ± 0.20	39.25± 0.20	38.76 ± 0.20	38.68 ± 0.25	39.5	40	--	39.6	--	--
Pulse rate (per min)	111.66 ± 2.39	108 ± 2.7	108 ±2.68	87.4 ± 1.78	87 ± 2.72	88.75 ± 1.5	92	98	--	96	--	--
Respiratory rate (per min)	35.16± 1.33	35.33 ±0.66	33.16± 0.74	40.2 ± 2.8	39.2 ±2.65	38.25±2.40	32	38	--	38	--	--

The rectal temperature in dogs A12 and A13 were 39.5°C and 39.6°C respectively on first day. The rectal temperature of A12 on seventh day was 40°C. Two dogs A12 and A13 were died on 11th and fifth day of treatment respectively.

4.9.3.2. Pulse rate: The mean pulse rate (per minute) before surgery in case of dogs with urolithiasis was 111.66 ± 2.39. It was 108 ± 2.70 and 108 ± 2.68 respectively on seventh and 21st day.

The mean pulse rate (per minute) in dogs with cystitis was 87.4 ± 1.78 on first day. It was 87.0 ± 2.72 and 88.75 ± 1.5 respectively on seventh and 21st day.

The pulse rate of A12 and A13 on first day was 92 and 96 respectively. The pulse rate of A12 on seventh day was 98.

4.9.3.3. Respiratory rate: The mean respiratory rate (per minute) before surgery in dogs with urolithiasis was 35.16 ± 1.33. It was 35.33 ± 0.66 and 33.16 ± 0.74 respectively on seventh and 21st day of surgery.

The mean respiratory rate (per minute) in dog with cystitis was 40.20 ± 2.80 on the day of treatment and 39.2 ± 2.65 on first day and seventh day respectively. It was 38.25 ± 2.40 on 21st day.

The respiratory rate in A12 was 32 and 38 on first and seventh day respectively. The respiratory rate of A13 was 38 on first day.

The variations observed in physiological parameters were within normal range except in dogs A12 and A13 and both showed rise in rectal temperature on day of presentation and also on seventh day by dog A12.

4.9.3.4. Colour of mucous membrane: Colour of visible mucous membranes were congested in all dogs except in A7 and A12. The colour of mucous membrane was

pale roseate in A7 and pale in A12. The colours of mucous membranes were normal in all dogs except in A12 where the colour was congested.

4.9.4. Catheterization

The patency of the urethra was checked by catheterization using six FG to 10 FG sized infant feeding tube lubricated with lignocaine gel according to size of the dogs. Catheter could not be passed beyond the middle of os-penis in five cases (A1, A2, A3, A5 and A6). Catheter could be passed up to the level of os penis in two cases (A4, and A6(R)). Catheterization was feasible up to the urethra at the level of ischial arch in one case (A1(R)). After locating the site of obstruction, urethrotomy, and or cystotomy was carried out to relieve the obstruction.

In dogs with bladder distension without mechanical obstruction, catheterization was carried out and relieved the urine and in other cases also catheterization was carried out to collect urine for analysis and culture and sensitivity test. On seventh and 21st days, catheterization was carried out to collect urine for analysis and culture and sensitivity test.

4.9.5. Urinalysis

4.9.5.1. Physical examination (Table 6):

4.9.5.1.1. Colour: Out of eight cases of urolithiasis, one dog (A1) had red coloured urine, two had dark yellow urine (A4 and A6) and others had pale yellow urine on the day of admission. The colour of urine was pale yellow on seventh day except in A1 where the colour was dark yellow. On 21st day in all cases the colour of urine was pale yellow.

Table 6. Observations on Physical examination of urine collected

Dog No.	Colour			Transparency			pH			Specific gravity		
	First day	Seventh day	21st day	First day	Seventh day	21st day	firstday	seventh day	21st day	First day	Seventh day	21st day
A1	Red	Dark yellow	Pale yellow	Turbid	Clear	Clear	6.5	7.5	6.5	1.02	1.02	1.025
A1 (R)	Pale yellow	Pale yellow	Pale yellow	Turbid	Clear	Clear	6.5	7.5	6.0	1.03	1.025	1.02
A2	Pale yellow	Not presented	Not presented	Turbid	Not presented	Not presented	6.5	Not presented	Not presented	1.02	Not presented	Not presented
A3	Pale yellow	Pale yellow	Pale yellow	Turbid	Clear	Clear	6.5	7.5	6.5	1.02	1.02	1.02
A4	Dark yellow	Pale yellow	Pale yellow	Turbid	Clear	Clear	6.5	7.5	6.5	1.025	1.025	1.02
A5	Pale yellow	Not presented	Not presented	Clear	Not presented	Not presented	6.5	Not presented	Not presented	1.02	Not presented	Not presented
A6	Dark yellow	Pale yellow	Pale yellow	Turbid	Clear	Clear	6.5	7.5	6.5	1.02	1.025	1.025
A6 (R)	Pale yellow	Pale yellow	Pale yellow	Clear	Clear	Clear	6.5	7.5	6.5	1.025	1.02	1.02
A7	Red	Red	Red	Turbid	Turbid	Clear	6	7.5	6.5	1.025	1.02	1.025
A8	Pale yellow	Pale yellow	Pale yellow	Turbid	Clear	Clear	6.5	7.5	6.5	1.02	1.025	1.02
A9	Red	Pale yellow	Pale yellow	Turbid	Clear	Clear	6.5	7.5	6.5	1.02	1.025	1.025
A10	Red	Pale yellow	Pale yellow	Turbid	Clear	Clear	6.5	7.5	6.5	1.025	1.02	1.025
A11	Pale yellow	Pale yellow	Pale yellow	Turbid	Clear	Clear	6.5	7.5	6.5	1.02	1.02	1.025
A12	Red	Red	-	Turbid	Turbid	-	6.5	6.5	-	1.015	1.01	-
A13	Red	-	-	Turbid	-	-	6.5	-	-	1.01	-	-

Out of five cases of cystitis, four (A7, A8, A9 and A10) had red coloured urine (haematuria) and one had pale yellow coloured urine. The colour of urine was changed from red to pale yellow after treatment in all dogs except in dog A7 in which the colour remained red on seventh and 21st day of treatment. In dogs A12 and A13, the urine colour was red. The colour of urine was red on seventh day also in dog A12. The dogs A2 and A5 were not presented on seventh and 21st day of observation.

4.9.5.1.2. Transparency: The appearance of urine was turbid in all cases except in A5 and A6(R) in which the appearance was clear on the day of presentation. On seventh day, the appearance of urine was clear in all cases except two (A7 and A12). The appearance was clear in all dogs on 21st day.

4.9.5.1.3. pH: The pH of all the urine samples were acidic on the day of presentation which changed to alkaline on the day seventh due to the administration of urinary alkalanizers and were changed to normal acidic pH on 21st day.

4.9.5.1.4. Specific gravity: Specific gravity of all urine samples were within normal range during the observation period except in A12 and A13 where the specific gravity was 1.015 and 1.010 respectively on the day of presentation. On seventh day, the specific gravity was 1.010 in A12.

4.9.5.2. Chemical examination (Table 7): Proteinuria was observed in all cases before treatment but the condition was inappreciable after treatment. In dog A12 and A13 severe proteinuria was observed (+++) and (++++) respectively on the day of presentation. In dog A12, on seventh day also there was severe proteinuria. The presence of blood was detected in A1, A7, A8, A9, A10, A12 and A13 on the day of presentation and seventh day in A7 and A12.

Table 7. Observations on chemical examination of urine collected.

Dog No.	Protein			Blood		
	Ist day	7th day	21stday	Ist day	7th day	21stday
A1	++	+	Nil	Present	Nil	Nil
A1 (R)	+	Nil	Nil	Nil	Nil	Nil
A2	+	*	*	Nil	*	*
A3	++	Nil	Nil	Nil	Nil	Nil
A4	++	Nil	Nil	Nil	Nil	Nil
A5	+	*	*	Nil	*	*
A6	++	Nil	Nil	Nil	Nil	Nil
A6(R)	++	Nil	Nil	Nil	Nil	Nil
A7	+++	++	Nil	Present	Present	Nil
A8	+	Nil	Nil	Present	Nil	Nil
A9	++	Nil	Nil	Present	Nil	Nil
A10	+	Nil	Nil	Present	Nil	Nil
A11	+	Nil	Nil	Nil	Nil	Nil
A12	+++	++++	**	Present	Present	**
A13	++++	**	**	Present	**	**

+ - Mild
++ - Moderate
+++ - High
++++ - Very high

* - Dog not presented
**- Dog died

Table 8. Observations on microscopic examination of urine sediments.

Dog No.	RBC/hpf			Pus cells/hpf			Epithelial cells/hpf			Crystals		
	1st day	7th day	21st day	1st day	7th day	21st day	1st day	7th day	21st day	1st day	7th day	21st day
A1	++++	+++	+	++++	+++	++	+	+	+	Ca-oxalate	Nil	Nil
A1(R)	++	+	+	+++	+	+	+			Nil	Nil	Nil
A2	+++	N.A.	N.A.	++++	N.A.	N.A.	+	N.A.	N.A.	Ca-oxalate	Nil	Nil
A3	++	+	+	+++	+	+	+	+	+	Nil	Nil	Nil
A4	+	0	0	+++	+	+	+	+	0	Ca-oxalate	Nil	Nil
A5	++	N.A.	N.A.	++	N.A	N.A	+	+	+	Nil	Nil	Nil
A6	+	+	+	++++	+	0	+	0	0	Nil	Nil	Nil
A6 (R)	++	+	+	++++	+	0	+	0	0	Nil	Nil	Nil
A7	++++	++++	++	++++	++++	+	+	+	0	Nil	Nil	Nil
A8	++++	++	0	+++	++	+	+	+	0	Nil	Nil	Nil
A9	++++	++	+	+++	++	+	+	0	0	Nil	Nil	Nil
A10	++++	++	+	++++	+	+	+	0	0	Nil	Nil	Nil
A11	+	0	0	+++	++	+	+	+	0	Nil	Nil	Nil
A12	++++	++++	-	++++	++++	-	++	+	-	Nil	Nil	Nil
A13	++++	-	-	++++	-	-	+++	-	-	Nil	Nil	Nil

RBC/hpf				Pus cells/hpf				Epithelial cells/hpf	
Numerous	++++	Few (1-2)	+	Numerous	++++	Few (1-2)	+	High (15-20)	+++
Moderate (4-6)	+++	Absent	0	Moderate (15-20)	+++	Absent	0	Moderate (3-4)	++
Mild (2-4)	++			Mild (5-4)	++			Mild (2-3)	+

Table 9. Observations on culture and sensitivity test of urine sample of dogs affected with urolithiasis.

Dog No.	First day		Seventh day		21st day	
	Culture and sensitivity tests	Antibiotic administered	Culture and sensitivity tests	Antibiotic administered	Culture and sensitivity tests	Antibiotic administered
A1	Organism isolated was Streptococci. The organism was sensitive to ciprofloxacin (+++), chloramphenicol (+++), gentamycin (++) and resistant to amoxycillin and penicillin G	Ciprofloxacin (250 mg) one tablet twice daily for seven days	No growth	Ciprofloxacin (250 mg) one tablet twice daily for two weeks	No growth	Nil
A1 (R)	Organism isolated was Streptococci. Sensitive to amoxycillin(+++), ciprofloxacin (+++), ampicillin (+++)	Amoxycillin-Cloxacillin (250mg) one tablet thrice daily for seven days	No growth	Amoxycillin-Cloxacillin (250mg) one tablet thrice daily for two weeks	No growth	Nil
A2	Streptococci could be isolated. Sensitive to ciprofloxacin (+++), amoxycillin (++) and gentamycin (++)	Ciprofloxacin (250 mg) half tablet twice daily for seven days	**	Advised to continue Ciprofloxacin (250 mg) half tablet twice daily for two weeks	**	Nil

**-Dog not presented

Contd.

Table 9. Continued. Observations on culture and sensitivity test of urine sample of dogs affected with urolithiasis.

Dog No.	First day		Seventh day		21st day	
	Culture and sensitivity tests	Antibiotic administered	Culture and sensitivity tests	Antibiotic administered	Culture and sensitivity tests	Antibiotic administered
A3	Organism isolated was *E.coli*. Sensitive to ciprofloxacin (+++), ofloxacin(+++),gatifloxacin (+++) and chloramphenicol (++)	Ciprofloxacin (250 mg) half tablet twice daily for seven days.	No growth	Ciprofloxacin (250 mg) half tablet twice daily for two weeks.	No growth	Nil
A4	Organism isolated was streptococci. Sensitive to ciprofloxacin (+++), amoxycillin (++) and enrofloxacin (+)	Ciprofloxacin (250 mg) half tablet twice daily for seven days.	No growth	Ciprofloxacin (250 mg) half tablet twice daily for two weeks.	No growth detected	Nil
A5	No growth detected. Dog was treated with antibiotic by local veterinarian	Amoxycillin-Cloxacillin (250mg) one tablet thrice daily for seven days.	**	Advised to continue Amoxycillin-Cloxacillin (250mg) one tablet thrice daily for two weeks	**	Nil
A6	No growth detected. Dog was treated with antibiotic by local veterinarian	Amoxycillin_Cloxacillin (250mg) one tablet thrice daily for seven days	No growth	Amoxycillin_Cloxacillin (250mg) one tablet thrice daily for two weeks.	No growth detected	Nil
A6(R)	Staphylococcus spp.was isolated. Sensitive antibiotics were ciprofloxacin (+++),cefotaxim (+++) and gatifloxacin (+++)	Ciprofloxacin (250 mg) half tablet twice daily for seven days	No growth.	Ciprofloxacin (250 mg) one tablet twice daily for two weeks.	No growth	

** Dogs not presented

In all urine samples, glucose, ketone bodies, bile pigments and bile salts were not detected on the day of presentation, seventh and 21st day.

4.9.5.3. Microscopic examination of urine sediments (Table 8): Microscopic examination of urinary sediments from dogs (A1, A2 and A4) revealed the presence of calcium oxalate crystals on the day of presentation and the crystals were appeared as small and colourless square envelopes. No crystals were detected on seventh and 21st day. In all other dogs, no crystals were detected in any of the observation period.

In dogs A1, A7, A8, A9, A10, A12 and A13 had haematuria at the time of admission and the number of erythrocytes per high power field was numerous. After treatments, on seventh and 21st day normal levels of erythrocytes per high power field were observed in all dogs. The dogs A7 and A12 had erythrocytes in urine even after treatment on seventh day.

All dogs showed pus cells in urine sediment on the day of presentation except A5. On seventh and 21st day of treatment, normal levels of pus cells per high power field were detected.

In all dogs epithelial cells were within normal range except in A12 and A13 where the number of epithelial cells per high power field was higher than normal.

4.9.6. Culture and sensitivity test of urine samples (Table 9, Table 10 and Table 11)

The urine samples showed growth of organism in Brain Heart Infusion agar in all dogs except in A5 and A6 where they had treated with antibiotics by the local veterinarian before presenting to the clinics.The organism isolated in dogs with urolithiasis was Streptococci Spp in A1, A1(R), A2 and A4, Staphylococci Spp in

A6(R) and *E.coli* in A3. The antibiotic sensitive in all cases was ciprofloxacin and amoxycillin was found sensitive only in one dog. (Table 9)

In all dogs with cystitis, the organism isolated was *E. coli.* In dogs A7 and A8, the colony count on the day of presentation was more than one lakh colony forming unit per milliliter, in A10 and A11, it was more than 50,000 colony forming unit per milliliter and in A9, more than 25,000 colony forming unit per milliliter. The antibiotics sensitive were ciprofloxacin, pefloxacin, enrofloxacin, gatifloxacin, cefotaxime, ceftriaxone and amikacin in three cases and along with these chloramphenicol and nitrofurantoin in one case each.

In dogs A9, A10 and A11, a course of antibiotic therapy with ciprofloxacin was sufficient to cure the infection and no growth could be detected on seventh day. The same antibiotic administration was continued for two more weeks.

In dog A7, *E. coli* organism could be isolated on seventh day also and the colony count was reduced to more than 50,000 colony forming unit per milliliter. The antibiotics sensitive were gatifloxacin, pefloxacin, cefotaxim, ceflriaxone and ofloxacin and resistant to ciprofloxacin. Gatifloxacin (400 mg) once daily for seven days was administered. On next seventh day, no growth could be detected and the same antibiotic was advised to continue for two more weeks.

The dog A8 was administered with ciprofloxacin at the dose rate of 10 mg/kg body weight for seven days. On seventh day, the colony count remains unchanged and was more than one lakh colony forming unit/millilitre and sensitive antibiotics were norfloxacin, gatifloxacin, pefloxacin and ofloxacin. The organism was resistant to ciprofloxacin and administered norfloxacin at the dose rate of 22mg/ kg body weight twice daily for seven days. On reculturing the urine on next seventh day revealed reduction in colony count to more than 50,000 colony forming unit/ milliliter and sensitive antibiotics were gatifloxacin and amikacin.

Table 10. Observations on culture and sensitivity test of urine sample of dogs affected with cystitis.

Dog No.	First day		Seventh day		14th day		21st day	
	Culture and sensitivity test	Antibiotic administered	Culture and sensitivity test	Antibiotic administered	Culture and sensitivity test	Antibiotic administered	Culture and sensitivity test	Antibiotic administered
A7	Organism isolated was *E. coli*. Colony count was more than one lakh cfu/ml. Sensitive to ciprofloxacin (+++) pefloxacin (+++) enrofloxacin (+++),gatifloxacin (+++)cefotaxime (++)ceftriaxone(++) amikacin(++)	Ciprofloxacin (250 mg) one tablet twice daily for seven days	Organism isolated was *E. coli*. Colony count was more than 50,000 cfu/ml. Sensitive antibiotics are gatifloxacin(+++) pefloxacin(+++) ofloxacin(+++) and amikacin(++)	Gatifloxacin (400 mg) one tablet daily for seven days	No growth	Gatifloxacin (400 mg) one tablet daily for two weeks	Not conducted	Gatifloxacin (400 mg) one tablet daily continued
A8	Organism isolated was *E. coli*. Colony count was more than 1 lakh cfu/ml. Sensitive to ciprofloxacin(+++)ofloxacin(+++) pefloxacin(++) gatifloxacin (+++) cefotaxime,(++)ceftriaxone (++)amikacin(+++)	Ciprofloxacin (250 mg) one tablet twice daily for seven days	Organism isolated was *E. coli*. Colony count more than one lakh cfu/ml. Sensitive to norfloxacin(+++) gatifloxacin,(+++) pefloxacin(+++) cefotaxime(+++) Resistant to ciprofloxacin	Norfloxacin (400 mg) half tablet twice daily for seven days	Organism isolated was *E. coli*. Colony count more than 50,000 cfu/ml. Sensitive to gatifloxacin(+++) and amikacin(+++) Resistant to norfloxacin	Gatifloxacin (400 mg) one tablet once daily for seven days	No growth.	Gatifloxacin (400 mg) one tablet once daily for two weeks.

Table 10. Continued. Observations on culture and sensitivity test of urine sample of dogs affected with cystitis.

Dog No.	First day		Seventh day		14th day		21st day	
	Culture and sensitivity test	Antibiotic administered	Culture and sensitivity test	Antibiotic administered	Culture and sensitivity test	Antibiotic administered	Culture and sensitivity test	Antibiotic administered
A9	Organism isolated was *E. coli*. Colony count more than 25,000 cfu/ml. Sensitive antibiotics were ciprofloxacin(+++) ofloxacin(+++) gatifloxacin(+++) norfloxacin (+++) nitrofurantoin(++) cefotaxim,(++)ceftrioxone(++)	Ciprofloxacin (250 mg) half tablet twice daily for seven days	No growth	Ciprofloxacin (250 mg) half tablet twice daily for two weeks	Not conducted	Ciprofloxacin (250 mg) half tablet twice daily continued	No growth	Nil
A10	Organism isolated was *E. coli*. Colony count more than 50,000 cfu/ml. Sensitive to ciprofloxacin (+++) norfloxacin(+++) ofloxacin(+++) pefloxacin(+++) cefotaxime(+++) ceftrioxone(++)	Ciprofloxacin (250 mg) half tablet twice daily for seven days	No growth	Ciprofloxacin (250 mg) half tablet twice daily for two weeks	Not conducted	Ciprofloxacin (250 mg) half tablet twice daily continued	No growth	Nil
A11	Organism isolated was *E. coli*. Colony count more than 50,000 cfu/ml. Sensitive antibiotics were ciprofloxacin(+++) ofloxacin(+++) chloramphenicol(++) cefotaxime(++) ceftriaxone(+++)	Ciprofloxacin (250 mg) one tablet twice daily for seven days	No growth	Ciprofloxacin (250 mg) one tab twice daily for two weeks	Not conducted	Ciprofloxacin (250 mg) one tab twice daily continued	No growth	Nil

Table 11.Observations on culture and sensitivity test of urine sample of dogs with prostatic abscess and bladder tumour

Dog No.	First day		Seventh day	
	Culture and sensitivity test	Antibiotic administered	Culture and sensitivity test	Antibiotic administered
A12	Organism isolated was *E. coli*. Colony count was more than one lakh cfu/ml. Sensitive antibiotics were ciprofloxacin (+++), enrofloxacin (+++), ofloxacin (+++), gatifloxacin (+++), cefotaxim(++)	Enroloxacin at the dose rate of five mg/kg body weight intramuscularly for seven days	Organism isolated was *E. coli*. Colony count was more than one lakh cfu/ml. Sensitive antibiotic were gatifloxacin (+++), pefloxacin (+++), ofloxacin (++) ,cefotaxime (++)and resistant to enrofloxacin	Gatifloxacin (400 mg) once daily orally for three days (Dog died on 11th day)
A13	Organism isolated was staphylococcus. Colony count was more than one lakh cfu/ml. Sensitive antibiotic were ciprofloxacin (+++), enrofloxacin (+++), gatifloxacin (+++), amoxycillin (++)	Amoxycillin- cloxacillin 10 mg/kg body weight intravenously for five days (dog died on fifth day)	--	

Table12. Observations on haematological parameters of dogs affected with urolithiasis, cystitis, prostatic abscess and bladder tumour.

Haemogram	Urolithiasis (Mean ± S.E.) n=6			Cystitis (Mean ± S.E.) n=5			Prostatic abscess			Bladder tumour		
	1st day	7th day	21st day	1st day	7th day	21st day	1st day	7th day	21st day	1st day	7th day	21st day
Total erythrocyte count (10^6/cumm)	5.88 ± 0.35	6.14± 0.42	6.54± 0.38	5.14± 0.35	5.36± 0.49	5.72± 0.63	5.41	5.20	-	4.12	-	-
Total leukocyte count (10^3/cumm)	20.16± 1.28	13.90± 1.50	12.66± 1.88	25.30± 5.76	20.20± 5.43	13.15± 3.20	19.80	32.60	-	13.8	-	-
Haemoglobin (g/dl)	11.20± 0.73	12.06± 0.86	12.70± 0.94	10.35± 1.44	11.00± 1.60	11.68± 1.73	9.40	9.20	-	8.3	-	-
VPRC (%)	35.00±2.13	36.67±2.46	38.67±2.46	28.25±2.32	32.75±3.50	35.00±4.32	28	26	-	24	-	-
Neutrophils (%)	81.00 ± 0.73	73.00± 1.3	72.00±2.00	80.75± 1.50	72.80±3.20	71.00±1.78	80	82	-	80	-	-
Lymphocytes (%)	16.17± 0.60	24.83± 1.58	25.83± 2.0	18.00± 1.04	25.20± 2.69	26.20±1.93	18	15	-	16	-	-
Monocytes (%)	0.83±0.40	0.33±0.21	0.33±0.21	0.2±0.20	0.20±0.20	0.50±0.50	0	1	-	0	-	-
Eosinophils (%)	1.50±0.34	1.17±0.31	1.83±0.16	1.20±0.49	1.00±0.57	1.25±0.25	2	2	-	4	-	-

Gatifloxacin (400 mg) one tablet once daily was prescribed for next seven days. There after the urine sample showed no growth on subsequent urine culture and advised to continue the same antibiotic for two more weeks. In dog A12, culture and sensitivity test revealed *E. coli* and the colony count was more than one lakh colony forming unit/ml and the sensitive antibiotics were ciprofloxacin, enrofloxacin, gatifloxacin, pefloxacin and cefotaxim. Enrofloxacin at the dose rate of five mg/kg body weight was administered intramuscularly for seven days but not responded to the treatment. The urine culture on day seventh revealed the same organism and colony count also same and the sensitive antibiotics were gatifloxacin, pefloxacin and cefotaxim and administered gatifloxacin (400mg) orally once daily but the dog died on 11^{th} day.

The dog A13 with bladder tumour, the organism isolated was Staphylococcus and the colony count was more than one lakh colony forming unit/ml and the sensitive antibiotics were ciprofloxacin, amoxycillin, enrofloxacin and gatifloxacin. The antibiotic administered was amoxycillin-cloxacillin at the dose rate of 10 mg/kg body weight intravenously.

4.9.7. Prostate fluid analysis

In one case with prostatic abscess, the prostate gland was messaged per rectum and the urethral discharge collected was stained and observed under microscope. Numerous neutrophils could be observed under high power of the microscope.

4.9.8. Haematological Parameters (Table 12)

4.9.8.1. Total erythrocyte count (TEC): In dogs with urolithiasis, the mean total erythrocyte count (10^6/cu.mm) was 5.88 ± 0.35 before surgery and 6.14 ± 0.42 and 6.54 ± 0.38 on seventh and 21^{st} day of surgery respectively.

In dogs with cystitis, the mean total erythrocyte count (10^6/cu.mm) was 5.14 ± 0.35 before treatment and 5.36 ± 0.49 and 5.72 ± 0.63 on seventh and 21st day of after treatment respectively.

The total erythrocyte count (10^6/cu.mm) on seventh and 21st day revealed increase from pre treatment value and was within normal range.

The total erythrocyte count (10^6/cu.mm) was 5.41 in dog A12 on first day and 5.20 on seventh day and was within normal range. The total erythrocyte count (10^6/cu.mm) was 4.12 on first day in dog A13 and was less than normal range.

4.9.8.2. Haemoglobin concentration: In dogs with urolithiasis, the mean haemoglobin concentration (g/dl) was 11.20 ± 0.73 before surgery and 12.06 ± 0.86 and 12.70 ± 0.94 on seventh and 21st day of surgery. The haemoglobin concentration was found to be slightly less than normal on first day and returned to normal on 21st day.

In dogs with cystitis the mean haemoglobin concentration (g/dl) was 10.35 ± 1.44 on first day and 11.00 ± 1.60 and 11.68 ± 1.73 on seventh and 21st day of treatment respectively. The haemoglobin concentration was found to be less than normal on first day and returned towards normal on 21st day.

The haemoglobin concentration (g/dl) of A12 was 9.40 on first day and 9.20 on seventh day. The haemoglobin concentration of A13 was 8.30 on first day. The values were less than normal.

4.9.8.3. Volume of Packed Red Cell (VPRC): The mean volume of packed red cell (%) was 35.00 ± 2.13 before surgery and 36.67 ± 2.46 and 38.67 ± 2.46 on seventh and 21st day of surgery respectively in dogs with urolithiasis. The VPRC was found to be increased within normal range on 21st day.

The mean volume of packed red cell (%) was 28.25 ± 2.32 on first day and 32.75 ± 3.50 and 35.00 ± 4.32 on seventh and 21st day of treatment in dogs with cystitis. The mean VPRC was found to be less than normal on first day and returned towards normal on 21st day.

The volume of packed red cell (%) was 28 on first and 26 on seventh day in dog A12. The volume of packed red cell volume of dog A13 was 24 on first day. The observations were less than normal.

4.9.8.4. Total Leukocyte Count (TLC): In dogs with urolithiasis the mean total leukocyte count (10^3/cu.mm) was 20.16 ± 1.28 before surgery and 13.90 ± 1.50 and 12.66 ± 1.88 on seventh and 21st day of surgery respectively. The total leukocyte count was observed to be high preoperatively, lowered on seventh day and towards normal on 21st day.

In dogs with cystitis, the mean total leukocyte count (10^3/cu.mm) was 25.30 ± 5.76 before treatment on first day and was 20.20 ± 5.43 and 13.15 ± 3.20 respectively on seventh and 21st day of treatment. The total leukocyte count was high before treatment and was reduced considerably on 21st day.

In dog A12 suffering from prostatic abscess, the total leukocyte count (10^3/cu.mm) was 19.80 on first day and 32.60 on seventh day. The total leukocyte count was higher than normal in on day of presentation and again increased on seventh day.

In dog A13, the leukocyte count (10^3/cu.mm) was 16.80 on first day and was higher than normal.

4.9.8.5. Differential Leukocyte Count (DLC): The mean neutrophil count (%) was 81 ± 0.73 before surgery and 73 ± 1.30 and 72.00± 2.0 on seventh and 21st day of surgery respectively in dogs with urolithiasis. The mean neutrophil count (%) was

observed to be high preoperatively and returned towards normal on both seventh and 21st day of treatment

The mean neutrophil count (%) was 80.75 ± 1.50 on first day and 72.80 ± 3.20 and 71.00 ± 1.78 on seventh and 21st day respectively in dogs with cystitis. The mean neutrophil count was observed high on first and returned towards normal on 21st day.

In dog A12, the neutrophil count (%) was 80 on first day and 82 on seventh day. In dog A13, the neutrophil count was 80 on first day. The neutrophil count was observed to be higher than normal in both dogs.

The mean lymphocyte count (%) was 16.17 ± 0.60 before surgery and 24.83 ± 1.58 and 25.83 ± 2.0 on seventh and 21st day respectively in dogs with urolithiasis. The mean lymphocyte count was observed to be low before treatment and returned towards normal on 21st day.

The mean lymphocyte count (%) was 18.00 ± 1.04 before treatment and 25.20 ± 2.69 and 26.20 ± 1.93 on seventh and 21st day of treatment respectively in dogs with cystitis. The mean lymphocyte count was observed to be low before treatment and returned towards normal on 21st day.

The lymphocyte count (%) of A12 was 18 and 15 on first and seventh day respectively. The lymphocyte count of A13 was 16 on first day. The lymphocyte count was less than normal.

The mean monocyte count (%) was 0.83 ± 0.40 before surgery and 0.33 ± 0.21 on both seventh and 21st day of surgery respectively in dog with urolithiasis.

Table 13. Observations on biochemical parameters of the dogs affected with urolithiasis,cystitis, prostatic abscess and bladder tumour.

Biochemical parameters	Urolithiasis (Mean ± S.E.) n=6			Cystitis (Mean ± S.E.) n=5			Prostate abscess			Bladder tumour		
	1st day	7th day	21st day	1st day	7th day	21st day	1st day	7th day	21st day	1st day	7th day	21st day
Blood urea nitrogen (mg/dl)	38.55 ± 1.37	30.32± 1.82	25.8± 3.22	19.8± 2.15	18.4± 2.87	18.25± 3.70	94	180	--	332	--	--
Serum creatinine (mg/dl)	1.20 ± 0.11	0.86± 0.06	0.71± 0.11	1.07± 0.15	1.02± 0.04	0.87± 0.01	5.80	14.60	--	4.94	--	--
Total protein (g/dl)	7.03± 0.07	7.08± 0.06	7.25± 0.04	7.12± 0.08	7.20± 0.02	7.27± 0.02	7.30	7.20	--	7.60	--	--
Albumin (g/dl)	2.98 ± 0.06	2.98± 0.06	3.1± 0.03	3.04± 0.06	3.24± 0.09	3.27± 0.11	3.20	3.10	--	2.20	--	--
Globulin(g/dl)	4.1± 0.02	4.15± 0.02	4.18± 0.15	4.02± 0.04	4.12± 0.05	4.02± 0.04	4.10	4.10	--	5.40	--	--
A/G ratio	0.72± 0.01	0.73± 0.01	0.74± 0.01	0.75± 0.01	0.78± 0.06	0.81± 0.01	0.78	0.75	--	0.407	--	--
Serum sodium (mEq/L)	136± 0.39	139.5± 0.47	141± 1.45	144.25± 1.3	143 ± 1.33	142.97± 0.5	110	98.60	--	102.40	--	--
Serum potassium (mEq/L)	5.67± 0.08	5.53± 0.26	4.73± 0.01	4.77± 0.06	4.69± 0.12	4.54± 0.13	8.60	9.80	--	11.20	--	--

The mean monocyte count (%) was 0.20 ± 0.20 on first day before treatment and 0.20 ± 0.20 and 0.50 ± 0.50 on seventh and 21st day of treatment respectively in dogs with cystitis.

In dogs A12 and A13 the monocyte count was zero on first day and one on seventh day in dog A12.

The monocyte counts were within normal range.

The mean eosinophil count (%) was 1.50 ± 0.34 before surgery and 1.17 ± 0.31 and 1.83 ± 0.16 on seventh and 21st day of surgery respectively in dogs with urolithiasis.

The mean eosinophil count (%) was 1.20 ± 0.49 on first day before treatment and 1.00 ± 0.57 and 1.25 ± 0.25 on seventh and 21st day of treatment in dogs with cystitis.

The eosinophil count (%) of A12 was two on both first and seventh day in dog A13 was four on first day.

The eosinophil counts of all the cases were within normal range.

The thrombocyte count was done in dog A13 with bladder tumour and was found to be very low. The count was 5000 cells/µl instead of normal two lakh to four lakh cells /µl.

4.9.9. Biochemical Parameters (Table 13)

4.9.9.1. The blood urea nitrogen (BUN): The mean blood urea nitrogen (mg/dl) was 38.55 ± 1.37 before surgery and 30.32 ± 1.82 and 25.8 ± 3.22 on seventh and 21st day of surgery respectively in dogs with urolithiasis. The mean blood urea nitrogen was observed to be high on first day and returned to normal on 21st day.

The mean blood urea nitrogen (mg/dl) was 19.80 ± 2.15 on first day before treatment and 18.40 ± 2.87 and 18.25 ± 3.7 on seventh and 21st day after treatment in dogs with cystitis. The blood urea nitrogen level was within normal range.

The blood urea nitrogen (mg/dl) was 94 on first day and 180 on seventh day in dog A12. The blood urea nitrogen (mg/dl) was 332 on first day in dog A13. In both cases, the blood urea nitrogen values were significantly higher than normal values.

4.9.9.2. Serum creatinine: The mean serum creatinine (mg/dl) was 1.20 ± 0.11 before surgery and 0.86 ± 0.06 and 0.71 ± 0.11 on seventh and 21st day of surgery respectively in dogs with urolithiasis. The mean serum creatinine was slightly higher on first day and reduced to normal range on 21st day.

The mean serum creatinine (mg/dl) was 1.07 ± 0.15 on first day and 1.02 ± 0.04 and 0.87 ± 0.01 on seventh and 21st day in dogs with cystitis. The serum creatinine values were within normal range.

In dog A12, the serum creatinine (mg/dl) was 5.80 on first day and 14.60 on seventh day. In dog A13, the serum creatinine (mg/dl) was 4.94 on first day. In both cases, the serum creatinine values were higher than normal.

4.9.9.3. Serum total protein: The mean serum total protein level (g/dl) was 7.03 ± 0.07 before surgery and 7.08 ± 0.06 and 7.25 ± 0.04 on seventh and 21st day of surgery respectively in dogs with urolithiasis.

The mean total protein level (g/dl) was 7.12 ± 0.08 on first day and 7.20 ± 0.02 and 7.27 ± 0.02 respectively on seventh and 21st day of treatment in dogs with cystitis.

The total protein level (g/dl) of A12 was 7.30 and 7.20 on first and seventh day respectively. The total protein level of A13 was 7.60 on first day.

The total protein levels were within normal range in all dogs.

4.9.9.4. Serum Albumin: The mean albumin (g/dl) was 2.98 ± 0.06 before surgery and 2.98 ± 0.06 and 3.1 ± 0.03 on seventh and 21st day of surgery respectively in case of urolithiasis.

The mean albumin (g/dl) was 3.04 ± 0.06 on first day and 3.24 ± 0.09 and 3.27 ± 0.11 on seventh and 21st day in case of cystitis.

The albumin level (g/dl) was 3.20 and 3.10 on first and seventh day respectively in dog A12.

The albumin levels were within normal range in all cases

The albumin level (g/dl) was 2.20 on first day in dog A13 and was less than normal range.

4.9.9.5. Serum Globulin: The mean serum globulin level (g/dl) was 4.10 ± 0.02 before surgery and 4.15 ± 0.02 and 4.18 ± 0.15 on seventh and 21st day of surgery respectively in dogs with urolithiasis.

The mean serum globulin level (g/dl) was 4.02 ± 0.04 on first day and 4.12 ± 0.05 and 4.02 ± 0.04 on seventh and 21st day respectively in dogs with cystitis.

The serum globulin level (g/dl) was 4.10 on both first and seventh day in dog A12 and was within normal range.

Serum globulin (g/dl) was 5.40 on first day in dog A13 and was higher than normal.

4.9.9.6. Albumin/Globulin (A/G) ratio: The mean Albumin/Globulin (A/G) ratio was 0.72 ± 0.01 on first day and 0.73 ± 0.01 and 0.74 ± 0.01 on seventh and 21st day respectively in dogs with urolithiasis.

The mean albumin/globulin ratio was 0.75 ± 0.01 on first day and 0.78 ± 0.06 and 0.81 ± 0.01 on seventh and 21st day respectively in dogs with cystitis.

The A/G ratio of dog A12 was 0.78 on first and 0.75 on seventh day.

The A/G ratio values were within normal range.

In dog A13, the A/G ratio was 0.40 on first day and was found to be less than normal.

4.9.9.7. Serum Sodium: The mean serum sodium (mEq/L) was 136 ± 0.39 before surgery and 139.5 ± 0.47 and 141 ± 1.45 on seventh and 21st day of surgery respectively in dogs with urolithiasis. The serum sodium was found to be less than normal range on first day and returned to normal on 21st day.

The mean serum sodium (mEq/L) was 144.25 ± 1.30 on first day and 143 ± 1.33 and 142.97 ± 0.50 on seventh and 21st day respectively in cystitis cases. The serum sodium values were with in normal range.

The serum sodium (mEq/L) was 110 on first day and 98.60 on seventh day in dog A12. The serum sodium (mEq/L) was 102.40 on first day in dog A13. The serum sodium values were found to be less than normal value.

4.9.9.8. Serum potassium: The mean serum potassium (mEq/L) was 5.67 ± 0.08 on first day and 5.53 ± 0.26 and 4.73 ± 0.01 on seventh and 21st day in dogs with urolithiasis. The serum potassium level was found to be slightly higher on first day and returned to normal range on 21st day.

Table 14. Observations on colour, shape, type of calculi, pH of urine, species of organism isolated and antibiotic administered.

Dog No.	Colour	Shape	Type	pH of urine	Species of organism isolated	Antibiotic administered
A1	Light tan	Round and ovoid	Calcium oxalate and Calcium carbonate	Acidic	Streptococci	Ciprofloxacin (250 mg) one tablet twice daily for three weeks
A1(R)	Light tan	Round and ovoid	Calcium oxalate and calcium carbonate	Acidic	Streptococci	Amoxycillin-Cloxacillin (250mg) one tablet thrice daily for three weeks
A2	Grey	Rosette shaped and faceted	Calcium oxalate	Acidic	Streptococci	Ciprofloxacin (250 mg) ½ tablet twice daily for three weeks
A3	Grey	Ovoid	Calcium oxalate and uric acid	Acidic	*E.coli*	Ciprofloxacin (250 mg) ½ tablet twice daily for three weeks
A4	Dark tan	Jack stone shaped	Calcium oxalate and uric acid	Acidic	Streptococci	Ciprofloxacin (250 mg) ½ tablet twice daily for three weeks
A5	Green	Faceted and ovoid	Calcium oxalate and uric acid	Acidic	No growth	Amoxycillin-Cloxacillin (250mg) one tablet thrice daily for three weeks
A6	Medium tan	Faceted	Calcium phosphate and uric acid	Acidic	No growth	Amoxycillin_Cloxacillin (250mgone tablet thrice daily for three weeks
A6(R)	Medium tan	Pyramidal	Calcium phosphate and uric acid	Acidic	Staphylococci	Ciprofloxacin (250 mg) ½ tablet twice daily for three weeks

The mean potassium (mEq/L) level on first day was 4.77 ± 0.06 and 4.69 ± 0.12 and 4.54 ± 0.13 on seventh and 21st respectively in cystitis cases. The mean potassium level was within normal range.

The potassium level (mEq/L) of A12 dog was 8.60 on first day and 9.80 on seventh day. The potassium level (mEq/L) of A13 was 11.20 on first day. The values were significantly higher than normal range.

4.9.10. Out come of treatment

In cases of urolithiasis and cystitis, all dogs were cured except two dogs (A1 and A6) showed recurrence of the condition. The dogs A12 and A13 died on 11th and fifth day of treatment respectively due to renal failure. In dog A11, urinary incontinence still persists after curing the cystitis. So to enhance bladder tone bethanechol 10 mg orally every 8 hours was given but only slight improvement was noticed as reported by the owner.

4.9.11. Calculi analysis

4.9.11.1. Morphological appearance of calculi *(Table 14)*

4.9.11.1.1. Colours and quantity of the calculi: The calculi were light tan in A1 and A1 (R), medium tan in A6 and A6 (R), dark tan in A4, grey in A2 and A3 and green in A5. In dogs A1, A3 and A6 (R) there was single calculus. There were 35 calculi in A2, 18 in A5, 15 in A1 (R), 20 in A4 and 4 in A6.

4.9.11.1.2. Shapes of the calculi: The shape of calculi was round and ovoid in A1 and A1 (R), rosette shaped and faceted calculi in A2, ovoid in A3, jack stone in A4, both faceted and ovoid in A5, faceted in A6 and pyramidal shape in A6 (R).

4.9.11.1.3. Surface characteristics of the calculi: The Surface characteristics of calculi was smooth in A5, A6 and A6 (R), rough in A1, A1 (R), A2 and A3 and rough surface with blunt edged in A4.

4.9.11.1.4. Sizes of the calculi: The sizes of the urethral calculi were ranged from 0.8 cm x 0.2 cm to 0.4 x 0.3 cm size and sizes of the cystic calculi were ranged from 2.3 cm x 5.4 to 0.2 x 0.4 cm.

4.9.11.2. Qualitative Analysis of calculi *(Table 15):* Of the eight cases, calcium oxalate was the major component in six dogs (A1, A1 (R), A2, A3, A4 and A5) and calculi in dogs A1 and A1 (R) were containing calcium carbonate also. In dogs A3, A4 and A5 in addition to calcium oxalate uric acid was also present. The uroliths in two dogs A6 and A6 (R) were composed of calcium phosphate and uric acid. The uroliths in dog A2 was composed of calcium oxalate only.

From the study, it was found that the calculi containing calcium oxalate, calcium carbonate and uric acid (dogs A1, A1 (R), A2 and A4), were mostly associated with Streptococcal infection. In one dog (A6 (R)) with the calculi containing calcium phosphate and uric acid, the organism was Staphylococci. In A3 with calcium oxalate and uric acid calculi, *E.coli* was isolated. In two dogs, (A5 and A6) there was no growth because local veterinarian treated both with antibiotic. In all cases pH of urine was acidic. The sensitive antibiotic was ciprofloxacin in all cases except in A1(R) where both amoxycillin and ciprofloxacin was found to be sensitive.

Table 15. Observations on mineral composition of calculi retrieved from dogs under study.

Dog No.	Calcium	Oxalate	Phosphate	Uric acid	Magnesium	Carbonate	Ammonium	Cystine
A1	++	++	Nil	Nil	Nil	+	Nil	Nil
A1 (R)	++	++	Nil	Nil	Nil	+	Nil	Nil
A2	++++	++	Nil	Nil	Nil	Nil	Nil	Nil
A3	+++	+	Nil	++	Nil	Nil	Nil	Nil
A4	++	++	Nil	++	Nil	Nil	Nil	Nil
A5	+++	+	Nil	+++	Nil	Nil	Nil	Nil
A6	+++	Nil	+	+	Nil	Nil	Nil	Nil
A6 (R)	+++	Nil	+	+++	Nil	Nil	Nil	Nil

++++ - Most predominant
+++ - Moderately predominant
++ - Less predominant
+ - Least predominant

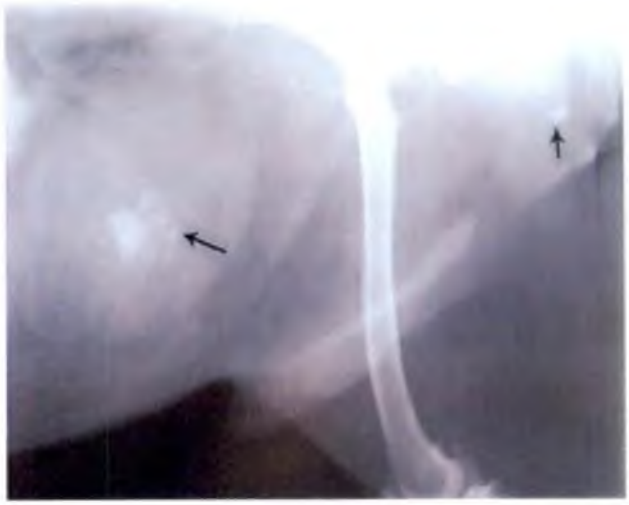


Fig. 3. Skiagram showing presence of calculi in the bladder and urethra at the level of ischial arch in dog A1 (R)

Fig. 4. Ultrasonography showing cystic calculi in dog A1(R)

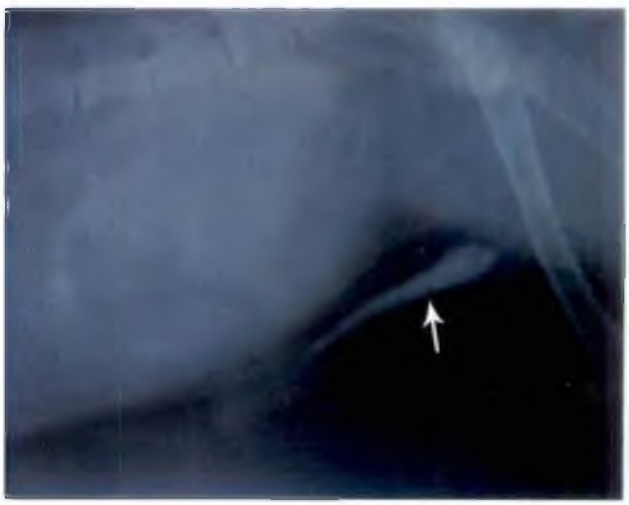


Fig. 5. Skiagram showing presence of calculi in the groove of os penis and distended urinary bladder in dog A2

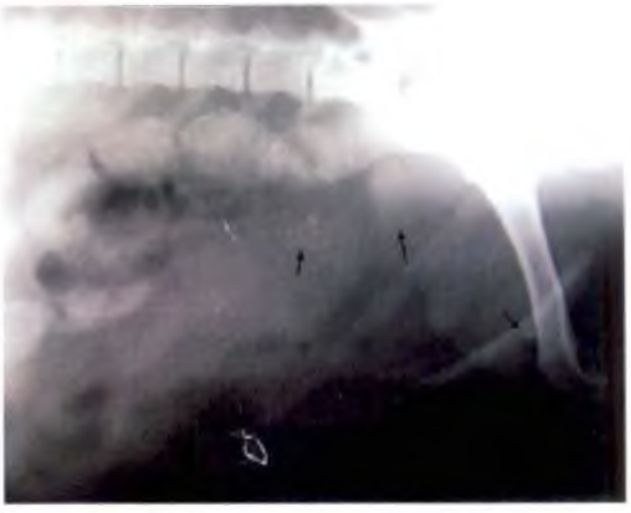


Fig. 6. Skiagram showing presence of calculi in the bladder, in the groove of os penis and enlargement of prostate in dog A3

Fig. 7. Skiagram showing presence of calculi behind the os penis in dog A4

Fig. 8. Skiagram showing distended urinary bladder in dog A6 (R)

Fig. 9. Contrast urethrogram showing presence of calculi behind os penis in dog A6 (R)

Fig. 10. Skiagram showing presence of thickening of bladder wall and enlargement of kidney in dog A7

Fig. 11. Double contrast cystogram showing intraluminal filling defect in dog A7

Fig. 12. ultrasound image showing hyperechoic mobile mass in the urinary bladder of dog A7

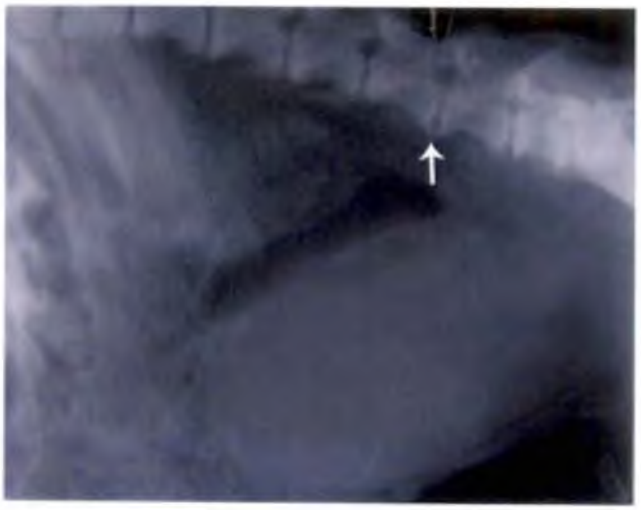


Fig. 13. Skiagram showing distended bladder and bridging of ventral vertebral bodies of 5th and 6th lumbar vertebrae in dog A11

Fig. 14. ultrasound image showing showing distended urinary bladder in dog A11

Fig. 15. ultrasound image showing thickening of bladder wall in dog A8

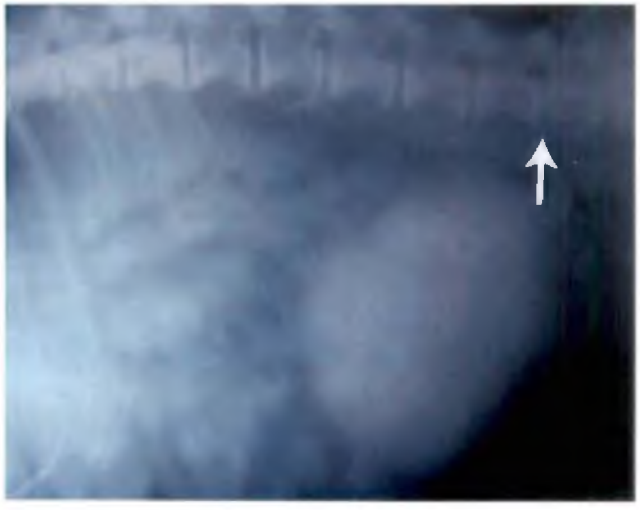


Fig. 16. Skiagram showing distended bladder and protrusion and calcification of disc between 6^{th} and 7^{th} lumbar vertebrae in dog A10

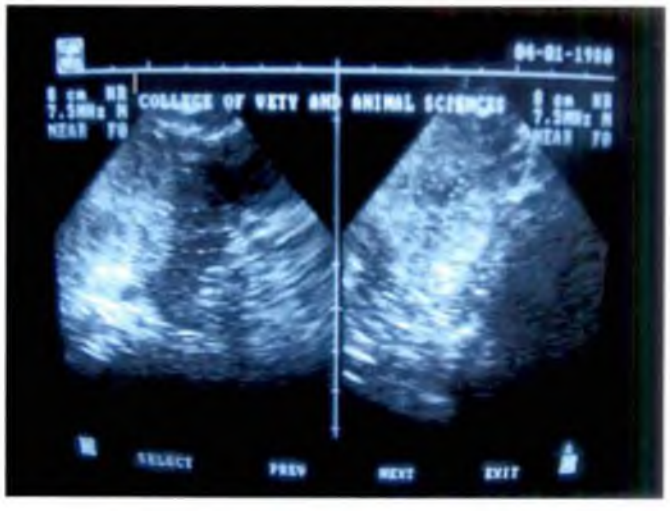


Fig. 17. ultrasound image showing prostatic abscess in dog A12

Fig. 18. Contrast cystogram showing intraluminal filling defect with in the bladder in dog A13

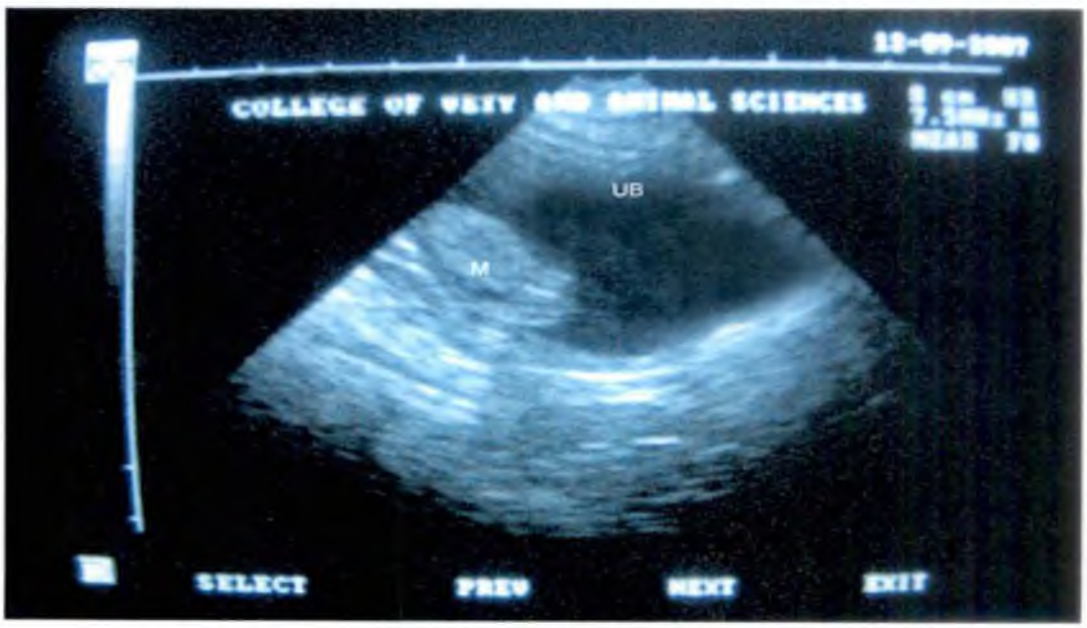


Fig. 19. Ultrasound image showing hyper echoic mass in the bladder in dog A13

Fig. 20. Isolation of retractor penis muscle and calculi inside the urethra in A6 (R)

Fig. 21. Prescrotal urethrotomy site on 7th day of surgery in dog A6 (R)

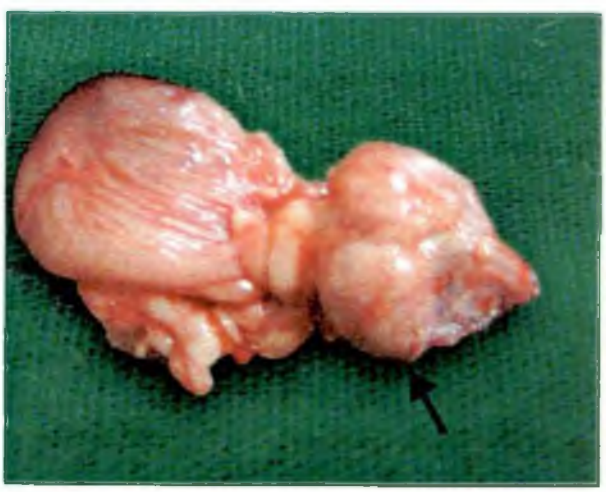


Fig 22.Necropsy specimen of prostatic abscess of dog A 12

Calculi retrieved from dogs with urolithiasis

Fig. 23. Calcium oxalate and calcium carbonate (dog A1)

Fig. 24. Calcium oxalate and calcium carbonate (dog A1 (R))

Fig. 25. Calcium oxalate (dog A2) - Rossette shaped

Fig. 26. Calcium oxalate and uric acid (dog A3)

Calculi retrieved from dogs with urolithiasis

Fig. 27. Calcium oxalate and uric acid (dog A4)-jack stone shaped calcium oxalate

Fig. 28. Calcium oxalate and uric acid (dog A5) - radiolucent

Fig. 29. Calcium phosphate and uric acid (dog A6)

Fig. 30. Calcium phosphate and uric acid (dog A6 (R)) - radiolucent

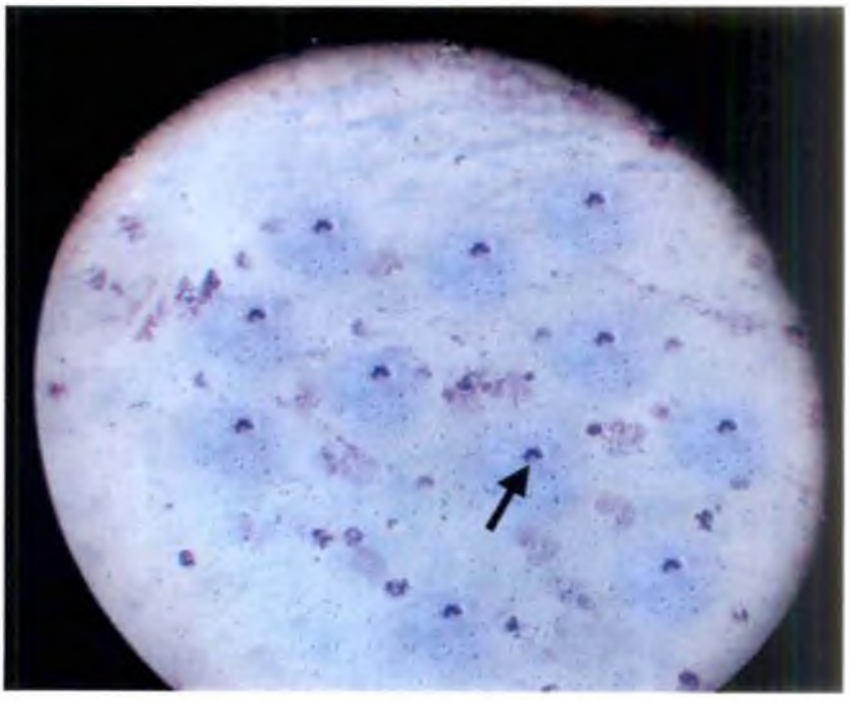


Fig. 31. Neutrophils in the prostatic fluid (dog A12) stained with Leishman stain - 40 X

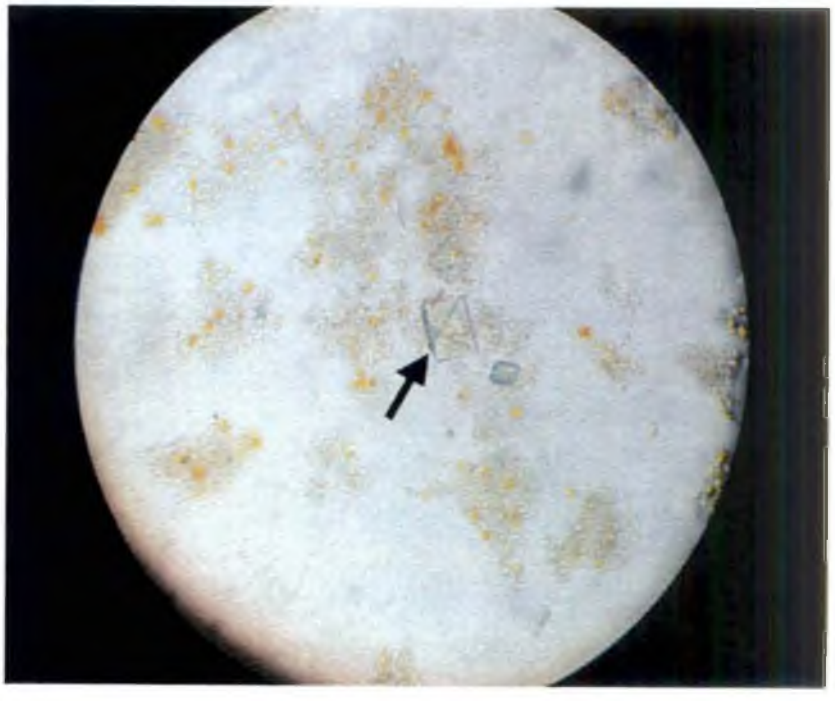


Fig. 32. Calcium oxalate crystals in the urine sediment from dog A2 - 40 X

Plate 1. Prescrotal urethrotomy in dog A4

A. Metal probe inserted through external urethral orifice.

B. Skin incision.

C. Urethral Incision.

D. Artery forceps introduced into the urethra.

E. Closed skin wound & catheter in position in the urethra.

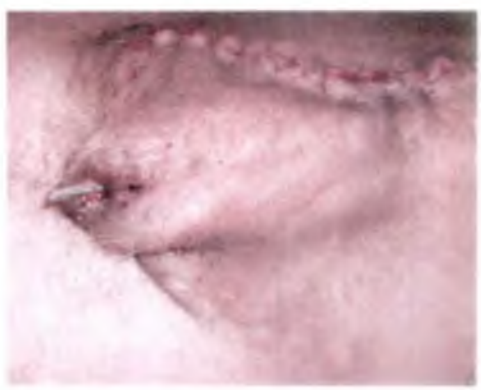
Plate 2. - Cystotomy in dog A6

A. Exteriorized urinary bladder

B. Incision on the dorsal aspect of urinary bladder

C. Cystotomy wound showing the calculi inside

D. Closure of cystotomy wound



E. Skin wound after suturing

Fig. 33. Incidence of lower urinary tract disorders

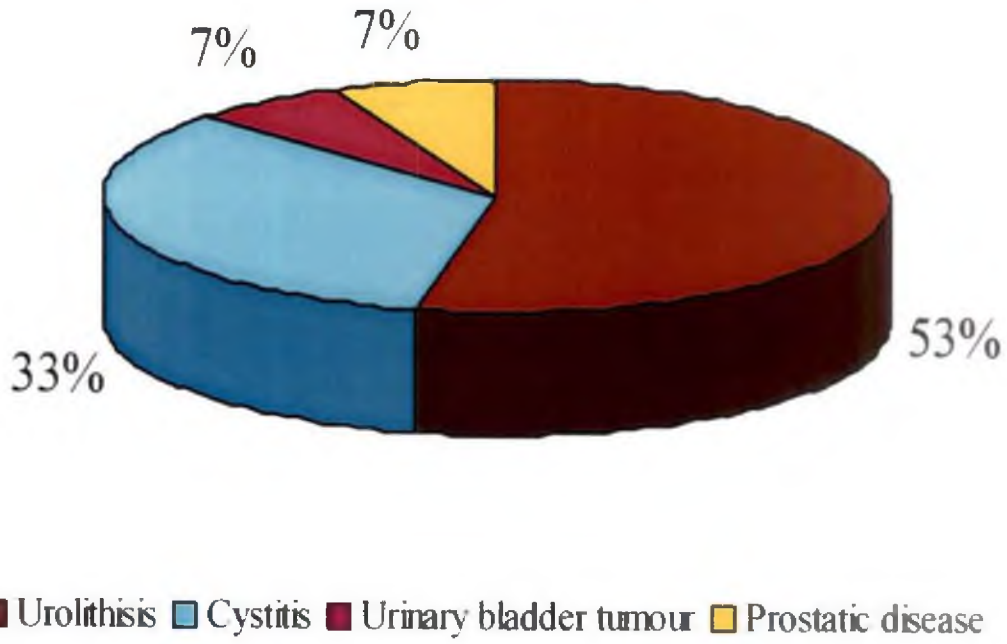


Fig. 34. Breed wise distribution of urolithiasis

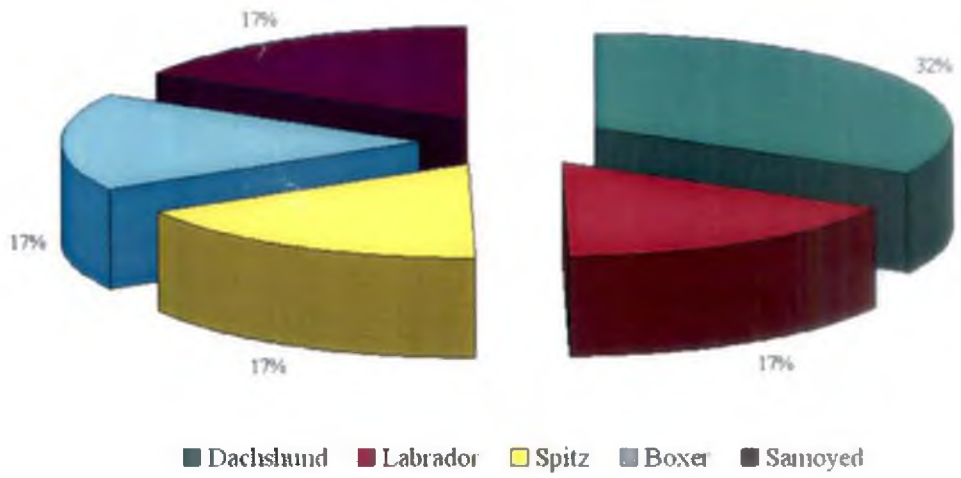
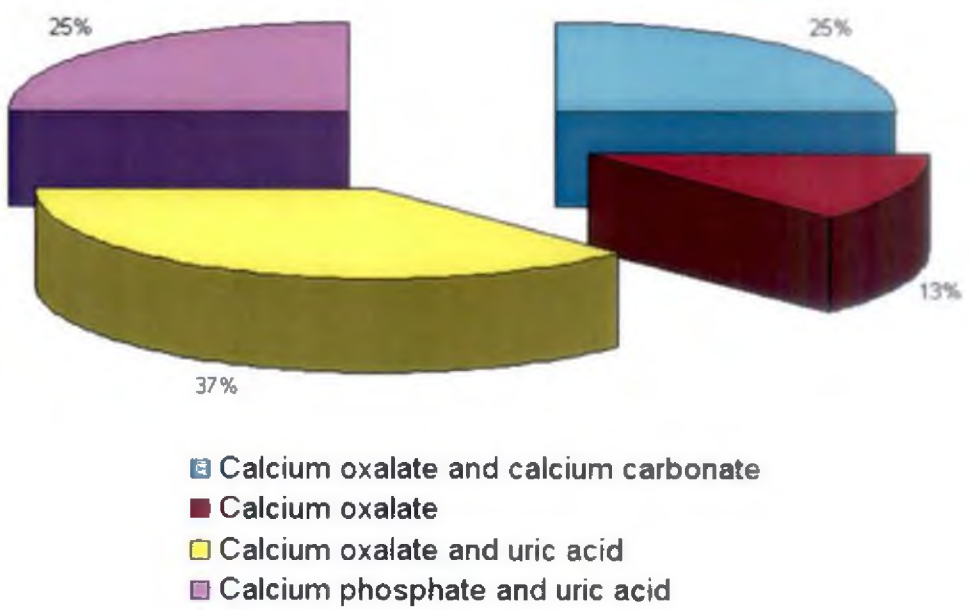


Fig. 35. Type of Calculi



Discussion

5. DISCUSSION

5.1. SELECTION OF DOGS

The present study was conducted in 15 cases in 13 dogs with symptoms of lower urinary tract disorders presented at the Veterinary College Hospital, Mannuthy and University Veterinary Hospital, Kokkalai.

The study included eight cases of urolithiasis, five cases of cystitis, one case each of bladder tumour and prostatic abscess. All the 15 clinical cases in dogs were evaluated for incidence, etiology, pathology, medical or surgical treatment and the postoperative management in case of surgical treatment.

5.2. INCIDENCE

Among the 15 cases of diseases of the lower urinary tract studied, the most common disease was urolithiasis (53.33%) followed by cystitis (33.33%) and urinary bladder neoplasia (6.66%) and prostate disease (6.66%). But according to Lulich *etal.* (2000), the three most commonly reported diseases affecting the lower urinary tract were cystitis (40%), urinary incontinence (24%) and urolithiasis (18%). Sosnar *et al.* (2005) reported urolithiasis as the third most frequent diseases of the lower urinary tract in dogs.

5.2.1. Age

The average age of incidence of urolithiasis in dog was seven years. This is in accordance with Brown *et al.* (1977a), Thilagar *et al.* (1996) and Ling *et al.* (1998a) Where as Osborne *et al.* (1981) and Houston *et al.* (2004) reported mean age of dogs with struvite urolithiasis as six years. According to Lulich *et al.* (1991) and Weichselbaum *et al.* (1998) mean age of dogs with calcium oxalate urolithiasis was

nine years and that for silica urolith was 5.8 years. Damodaran (2004) reported the age of incidence was 6.3 years.

The average age of incidence of cystitis was 6.8 years. The average age in male was eight years and in female was five years. Bartges (2004) reported bacterial urinary tract infection occurred in 14 per cent of dogs population during their life time and the incidence increases with age.

The age of incidence of prostatic abscess was nine years. This is in accordance with Krawiec and Heflin (1992), where the mean age of incidence of prostatic disease was 8.9 years.

The age of incidence of bladder tumour was 10 years. This is in accordance with Straufuss and Dean (1975), Krawiec (1991) and Goett and Degner (2003) where as Heng *et al.* (2006) reported age of incidence of leiomyomas and leiomyosarcomas as 12.5 and seven years respectively.

5.2.2. Breed

Occurrence of urolithiasis was more in Dachshunds (33%) followed by Labrador (16.66%), Spitz (16.66%), Boxer (16.66%) and Samoyed (16.66%). Higher incidence of urolithiasis in Dachshunds had been reported by Zontine (1975) and Brown *et al.* (1977a). The finding was also in accordance with Sosnar *et al.* (2005) where the small breeds and chondrodystrophic breeds were particularly susceptible to urolithiasis. Damodaran (2004) reported higher incidence in German Shepherd Dog followed by Pomeranian and Labrador. Singh *et al.* (2005) observed majority of urolithiasis in Spitz followed by Doberman.

Out of five dogs affected with cystitis, two were Dachshunds (40%), one each Labrador (20%), Rottweiler (20%) and German Shepherd Dog (20%). In one dog, cystitis was due to intervertebral disc disease and was a Dachshund. According to

McKee (2000) chondrodystrophoid breeds were particularly susceptible to intervertebral disc diseases.

The dog affected with prostatic abscess was German Shepherd. This is in accordance with Krawiec and Heflin (1992) where the authors reported Doberman Pinscher was the common breed prone for prostatic disease followed by German Shepherds. According to Kutzler and Yeager (2005) Doberman Pinschers and German Shepherds were the most common breeds affected with prostatic disease. The dog affected with bladder tumour was Cocker Spaniel. Strafuss and Dean (1975) reported that there was no breed predisposition in the occurrence of bladder tumour.

5.2.3. Sex

In the present study, all the dogs affected with urolithiasis were males. This is in accordance with Lulich *et al.* (1991), Thilagar *et al.* (1996), Lekcharoensuk *et al.* (2000), Nandi *et al.* (2003), Damodaran (2004) and Singh *et al.* (2005). Brown *et al.* (1977a) and Osborne *et al.* (1981) reported the incidence of struvite calculi in females as 60 per cent and in males as 40 per cent. Osborne *et al.* (1986) reported that uroliths occurred more frequently in female dogs than in male dogs.

Out of five dogs affected with cystitis, three were males and two were females. But according to the report of Osborne *et al.* (1985) and Bartges (2004) females dogs were more affected with urinary tract infection (UTI) than males. Osborne *et al.* (1985) also reported that shorter and broader urethra in female make them less barrier to ascending migration of bacteria. .

The dog affected with bladder tumour was a male. But according to Osborne *et al.* (1985) and they reported that bladder neoplasms were more common in females. Krawiec (1991) reported that fairly even distribution of bladder cancer between both sexes. As per the review of Goett and Degner (2003) older spayed female dogs were most often affected with bladder tumour.

5.3. CLINICAL SIGNS AND DURATION OF ILLNESS

In dogs with urolithiasis, all dogs showed reduced food and water intake and the colour of conjunctival mucous membranes was congested. All dogs with urolithiasis showed dribbling of urine and distended bladder. Vomiting was exhibited by three dogs (A1, A1(R) and A2) and haematuria by one dog (A1). These findings were in accordance with Rubin (1990a), Lipscomb (2004) and Singh *et al.* (2005).

All the dogs with cystitis except three dogs (A7, A8 and A9) showed difficulty in urination (dribbling) and bladder distension was detected in all dogs except two (A8 and A9). Vomiting was exhibited by dog A11, haematuria by four dogs (A7, A8, A9 and A10) and dog A8 exhibited gross haematuria at the end of micturition. Lees and Rogers (1986), Rubin (1990a) and Bartges (2004) described the same clinical signs in cystitis. Bartges (2004) also reported gross haematuria at the end of micturition in cystitis.

The dog A10 was not able to bear weight on hind limb, pedal reflex, patellar reflex and proprioception were absent on pelvic limbs. According to Moreau (1990) hind limb weakness due to spinal disorders could be predisposed for infection due to urinary stasis. Shaw (1990) reported upper or lower motor neuron disease caused urine retention resulted in urinary tract infection. Sturges and LeCouteur (2002) reported spinal cord injury causing loss of voluntary control of urination and large volume of urine accumulation leading to development of retention cystitis.

In the present study, a case of prostatic abscess (A12) was included. Per rectal examination with finger revealed enlargement of prostate and other clinical signs like dyschezia, haematuria, fever, urethral discharge and caudal abdominal pain were also present. These clinical signs were in accordance with Krawiec and Heflin (1992) and Kutzler and Yeager (2005). According to Krawiec and Heflin (1992) prostatic abscesses might developed secondary to chronic bacterial prostatitis and

could result in life threatening fulminating toxaemia and abscesses might be large enough to interfere with defaecation and urination.

In dog A13, the clinical signs exhibited were haematuria, dysuria, strangnuria and on palpation, a hard mass palpable within the urinary bladder. Straufuss and Dean (1975), Krawiec (1991) and Singh and Mohindroo (2007) reported the similiar clinical signs in cases of bladder tumour. In dog A13, other signs exhibited were bleeding from gum and petechiae over the skin of lower abdomen, tip of penis and gum due to thrombocytopenia. According to Gaschen and Teske (2005) thrombocytopenia was one of the most common haemostatic abnormalities in cancer patients and the life span of the platelets could be shortened, especially with metastatic tumour.

The duration of illness of dogs with urolithiasis was varied from two days to one month and that of cystitis was two days to one week. The duration of illness for prostatic abscess and bladder tumour was one week.

5.4. RADIOGRAPHIC EVALUATION

5.4.1 Survey Radiography

Survey radiography was performed invariably in all dogs except in A1. In dogs with urolithiasis, out of eight cases including two recurrences, the survey radiography revealed the calculi in five cases and two calculi were radiolucent. The survey radiography revealed the site of obstruction by the urinary calculi as ventral groove of os penis in three dogs (A2, A3 and A6), posterior to the os penis in one dog (A4), ischial arch of the urethra in one dog (A1 (R). The cystic calculi were detected in four dogs (A1 (R), A3 A6 and A9). In dog A3, along with urethral and cystic calculi, enlargement of prostate was also noticed. According to Brown *et al.* (1977a) most of the calculi were radioopaque and located in the bladder and urethra.

In dogs with cystitis, thickening of the bladder wall was noticed in A7 and in others bladder wall thickening was not evident in survey radiography. Bartges (2004) observed thickening of the bladder wall in cystitis.

In dog A10, calcification and protrusion of the disc between sixth and seventh lumbar vertebrae were observed and varying degree of calcification noticed in the second, third, fourth and fifth lumbar intervertebral space. In A9,there was bridging of ventral vertebral bodies between fifth and sixth lumbar vertebrae. Mc Kee (2000) explained the calcification of intervertebral space as a discrete mass or a hazy increase in opacity of the intervertebral foramen.

5.4.2. Contrast Radiography

The contrast medium used was sodium and meglumine salts of diatrizoic acid. Herrtage and Dennis (1987) reported the use of sodium and meglumine salts of diatrizoic acid as contrast medium for urinary system.

Double contrast cystography was conducted in A7 and intraluminal filling defect within the bladder lumen was observed. Johnston and Feeney (1984), Lavin (1994), Burk and Ackerman (1996) and Essman (2005) described contrast radiography of bladder and Ticer *et al.* (1980) described contrast urethrography for detection of radiolucent calculi. According to Burk and Ackerman (1996) double contrast cystography was the technique of choice for evaluation of the bladder wall and for detection of intraluminal filling defect caused by the mass that was not visible on survey radiography. In dog A13, on positive contrast cystography, intraluminal radiolucent filling defect within the bladder lumen was observed. Heng *et al.* (2006) diagnosed bladder wall neoplasm by positive contrast cystography as intraluminal filling defect.

In dogs A5 and A6 (R), no radio opaque calculi could be detected in survey radiography. In dog A5, on positive contrast urethrography, migration of contrast

medium up to the level of os penis was observed indicating calculi at the level of os penis. Burkman and Ackerman (1996) performed contrast urethrography to demonstrate radiolucent calculi. Analysis of the calculi revealed the presence of uric acid (+++) apart from calcium (+++) and oxalate (+) in dog A5 and calcium (+++) and phosphate (+) in dog A6 (R). Weichselbaum *et al.* (1998) and Bartges and Lane (2002) reported that urate calculi were radiolucent. Bartges and Lane (2002) graded the radioopacity of the calculi as calcium oxalate (++++), struvite (+ to ++++), urate and uric acid (0 to ++).

5.4.3. Location of the calculi

In the present study, out of eight cases with urolithiasis including two recurrences, the site of obstruction by the urinary calculi were in the ventral groove of os penis in five cases (A1, A2, A3, A5 and A6), posterior to the os penis in two cases (A4 and A6 (R)) and ischial arch of the urethra in one case (A1 (R). The urinary calculi within the urinary bladder were detected in three cases (A1 (R), A3, and A6). The finding was also agrees with Damodaran (2004) and Gatoria *et al.* (2005) and the authors reported that the most common site of obstruction was the ventral groove of os penis. Post os penis was the most common site as reported by Finco (1971) and Thilagar *et al.* (1996) and in the bladder by Ling *et al.* (1998d) and Nandi *et al.* (2003).

5.5. ULTRASONOGRAPHIC EVALUATION

Ultrasonographic evaluation was conducted in ten cases. Calculi in the urinary bladder were diagnosed in two cases by ultrasonography as hyperechoic foci in bladder lumen with distal acoustic shadowing. According to Voros *et al.* (1993) and Verma *et al.* (2006) urinary calculi were highly echogenic and produced intense acoustic shadowing.

Ultrasonographic evaluation was carried out in three dogs with cystitis and thickening of the urinary bladder wall was noted. Similar findings were reported by Nyland *et al.* (1995) and Verma *et al.* (2006). According to Nyland *et al.* (1995) wall thickening was most pronounced cranioventrally but became generalized in severe cases.

In two dogs (A7 and A10), along with diffuse bladder wall thickening, mobile, hyperechoic and non shadowing mass which indicated intraluminal blood clot. Park and Wrigley (2002) reported the ultrasonographic finding of blood clot as hyperechoic, non shadowing and mobile masses. In both cases, chronic cystitis was evident.

In one dog (A13) hyperechoic intraluminal mass was detected indicating bladder tumour. Singh and Mohindroo (2007) diagnosed bladder neoplasia by ultrasonography as echogenic intraluminal mass.

Prostatic abscess was detected in one dog. Enlarged prostate gland with focal heteroechogenic area was detected. This finding was in agreement with Mattoon and Nyland (1995) and they described prostate abscess as both hyperechoic and hypoechoic areas in the prostate gland. Barsanti and Finco (1986) reported ultrasonography as an aid to assess the prostatic consistency, size, shape, presence of fluid cavities and solid tissue masses.

5.6. MEDICAL MANAGEMENT

In dogs affected with urolithiasis, surgical removal of urinary calculi was done in all cases. After the surgery combination of amoxycillin and cloxacillin at the dose rate of 10 mg/kg was administered intramuscularly and thereafter prescribed combination of amoxycillin and cloxacillin tablets at the dose rate of 10 mg/kg body weight for three days. Specific antibiotics were administered on third day onwards based on the result of culture and sensitivity test of the urine collected. In dog A1(R)

amoxycillin – cloxacillin was found to be effective. Ciprofloxacin at the dose rate of 10 mg/kg body weight twice daily for seven days was administered in five dogs (A1, A2, A3, A4, and A6 (R). In two dogs (A5 and A6) where the urine culture on the day of surgery revealed no growth was administered with amoxycillin – cloxacillin. In dogs in which there was no growth of microorganisms on seventh day were advised to continue with the same antibiotic for two more weeks. All the dogs showed clinical cure after surgical removal of calculi and the micturition became normal. According to Shaw (1990) fluroquinolone offered some important advantages such as broad spectrum antibacterial activity, prostatic tissue penetration and high urine concentration. Amoxycillin and cloxacillin has been advocated in antimicrobial therapy of urinary tract infections by Dowling (1996).

Urinary alkalanizer and cystone tablets were administered after surgery in dogs with urolithiasis. Damodaran (2004) and Prasad *et al.* (2007) reported that the cystone therapy controlled the recurrence of urolith formation.

According to Ling and Gilmore (1977) amoxycillin was effective against staphylococci and streptococci. In the present study, amoxycillin was found to be resistant and ciprofloxacin was found to be sensitive. Damodaran (2004) reported growth of microorganisms in urine samples of dogs affected with urolithiasis were sensitive to ciprofloxacin.

In dogs with cystitis, treatment was initiated with ciprofloxacin (250 mg) one tablet twice daily for seven days and on third day onwards the antibiotics were administered based on the result of culture and sensitivity test. In three dogs (A9, A10 and A11), ciprofloxacin at the dose rate of 10 mg/kg body weight orally twice daily was found to be sufficient. In dog A7, after treatment with ciprofloxacin even though the colony count was reduced but the infection not completely cured. Therefore the antibiotic was changed according to the result of culture and sensitivity test to gatifloxacin (400mg) once daily for seven days. Thereafter no growth could be

detected on next seventh day and advised to continue the same antibiotic for two more weeks. In dog A8 also, the colony count was reduced but the infection persisted and therefore the antibiotic was changed to norfloxacin at the dose rate of 22mg/ kg body weight twice daily for seven days according to thee result of culture and sensitivity test of urine sample. In this case, the colony count was considerably reduced and gatifloxacin (400 mg) one tablet once daily was administered for next seven days. There after since culture of urine sample, no growth, it was advised to continue the same antibiotic for two more weeks.

In dog A9 with cystitis, small sized radio opaque cystic calculi were detected and constant irritation due to the calculi might have inflammation of the urinary bladder. Brown *et al.* (1977b), Lewis and Morris (1984) and Osborne *et al.* (1986) reported struvite calculi were associated with Staphylococcus infection and the urine was alkaline. But in this case the organism isolated was *E.coli* and the urine was acidic. Bartges (2005) reported the acidic pH of urine in *E. coli* infection.

In dog A11, urinary incontinence was persisted after relieving from cystitis. So to enhance bladder tone, bethanechol 10 mg orally every 8 hours and slight improvement noticed. Brown (2002) reported that any condition causing distension of bladder may result. in detrusor damage and atony and this was a disorder of the voiding phase of urination leading to over flow incontinence that might responded to pharmacological therapy. The author reported bethanechol as a cholinergic agent which enhance detrusor contractions.

In dog A12 with prostatic abscess, enrofloxacin at the dose rate of 5 mg/kg body weight was administered intramuscularly for seven days but not responded to the treatment. According to Kutzler and Yeager (2005) both chloramphenicol and enrofloxacin readily cross the epithelial membrane, however ciprofloxacin does not penetrate the prostatic wall.

5.7. SURGICAL MANAGEMENT

Surgical treatment was adopted in dogs with urolithiasis since more or less complete blockage of the urethra was present. The anaesthesia using intramuscular dministration of atropine sulphate as preanaesthetic. Induction of sedation by xylazine and local infiltration anaesthesia at the site of surgery using two per cent xylocaine was found to be satisfactory in all the dogs undergone urethrotomy. For cystotomy, ketamine at dose of 10 mg/kg body weight intramuscularly was also administered. The muscle relaxation and analgesia were found to be satisfactory. In all dogs, removal of the calculi and re-establishment of the patency of urethra were effective.

Calculi present in the groove of the os penis and behind the level of os penis could be removed by prescrotal urethrotomy. In one dog (A1 (R) the calculi lodged in the urethra at the level of ischial arch was removed by retrohydropropulsion into the bladder and removed by subsequent cystotomy as reported by Mitra *et al.* (1989).

For removal of larger calculi from the bladder, cystotomy was effective as reported by Hoff (1986), Ling *et al.* (1998b), Damodaran (2004) and Dolinsek (2004). Hence it is advisable to remove large cystic calculi by cystotomy since it may cause obstruction at the bladder neck and chronic cystitis. Flushing of urinary bladder during surgery with sterile normal saline facilitated clearing of urinary bladder thus eliminating small calculi and epithelial casts that act as a nidus for further calculi formation. In the present study recurrence was observed only in two dogs (A1 and A6).

5.7.1. Postoperative Management

Lactated Ringer's solution at the dose rate of 10ml/kg body weight was administered intravenously for all dogs after removal of calculi and establishment of the patency of urethra. The fluid therapy improved the general condition of dogs and

favoured urine out put. All the dogs were administered with amoxycillin – cloxacillin injection at the dose rate of 10 mg/kg body weight intramuscularly on the day of surgery and prescribed tablets of amoxycillin-cloxacillin at the dose rate of 10mg/kg body weight three times daily orally for three consecutive days. Thereafter specific antibiotics were administered on third day onwards based on the results of culture and sensitivity test of the urine collected. In dog A1(R) amoxicillin – cloxacillin was found to be effective. Ciprofloxacin at the dose rate of 10 mg/kg body weight twice daily orally for seven days was administered for five cases (A1, A2, A3, A4, and A6 (R). In two cases (A5 and A6) where the urine culture on the day of surgery revealed no growth was administered with amoxycillin–cloxacillin. In all cases, no growth of microorganisms on seventh day and advised to continue the same antibiotic for two more weeks. For alkalanization, di sodium hydrogen citrate one teaspoon twice daily for two weeks and cystone one tablet thrice daily were administered for three months.

5.7.2. Catheter tolerance

Catheter tolerance was poor in all dogs except in A3 and catheter was removed on the same day itself by all dogs. In dog A3, the catheter was retained and was removed on the 6th day of surgery. Damodaran (2004) reported difficulty in retaining the catheter.

5.7.3. Healing of the surgical wound

Healing of the surgical wound was good in all dogs. In the present study, urethrotomy wound was not sutured and left healed by second intention. According to Kyler and Stone (1998) the urethrotomy incision was left open to heal by second intention and epithelialization and the dog may urinate through both urethrotomy site and terminal urethra for up to two weeks. According to Bjorling (2002) healing of urethrotomy site was similar in both sutured and non sutured wounds and healing of the urethrotomy site was found to be good in non sutured wounds as reported by

Damodaran (2004). But according to Mohindra *et al.* (1996), degree of inflammation and intensity of fibrosis was relatively less in sutured urethral incision compared to non sutured urethral incisions.

Occasional bleeding and leakage of urine were noticed through the urethrotomy wound in all dogs up to six days. Haemorrhage observed through urethrotomy wound was more in nonsutured wound as per Bjorling (2002) and Lipscomb (2004). The authors reported postoperative haemorrhage for up to two weeks and urine leakage as the common complications of urethrotomy especially in non sutured wound. According to Bjorling (2002) and Mohindra *et al.* (1996) no urethral stricture occurred in any of the dog when urethral incision was not sutured.

In all dogs, the healing was complete by 21st day. Kyler and Stone (1998) reported complete healing of the urethrotomy incision in two to four weeks by second intention.

5.8. RECURRENCE OF UROLITHIASIS

Recurrence was observed in two dogs after surgery on 25th day in A1 and after three months in A6. In A1 (R), the calculi were noticed in the urinary bladder and one calculus at the level of ischial arch and in other dog obstruction was behind the os penis. Both dogs were subjected to surgery later. The recurrence might have been due to migration of cystic calculi into the urethra. Hess *et al.* (1998) reported recurrence up to 50 per cent of the dogs treated for calcium oxalate urolithiasis. Lewis and Morris (1984) described dietary protein and mineral restriction for preventing recurrence.

The absence of recurrence in most of cases in this study may be due to the flushing of urinary bladder during surgery, the selection of appropriate antibiotic for the treatment, administration of calculolytic drugs and alkalanization of the urine and proper diet management. Lewis and Morris (1984) reported the prevention of

recurrence of struvite urolithiasis through antimicrobial therapy, administration of urease inhibitors, acidification of urine and induction of diuresis.

5.9. MAIN ITEMS OF OBSERVATION

5.9.1. Signalment and Anamnesis

Among the dogs studied with urolithiasis, two had previous history of partial or complete urinary obstruction (A1 and A6). Both of them were subjected to retrohydropropulsion four months and one week before the presentation respectively. The dog A3 had cystitis three months before admission. Regarding feeding habit, all the dogs with urolithiasis were fed with more non-vegetarian diet regularly composed of meat, fish, and egg. Three dogs in the study came from the neighbouring state where they had hard water for drinking. Adams and Syme (2005) reported the mineral content of water might be a potential factor for calcium oxalate urolithiasis in humans.

5.9.2. Clinical examination

At the time of presentation, the general condition of all dogs with urolithiasis was dull and lethargic. Among five dogs with cystitis, three dogs were active, one was dull and lethargic and one was weak and recumbent. The dogs suffering from prostatic abscess and bladder tumour were weak and recumbent. After treatment all the dogs were found to be active except dogs with prostatic abscess and bladder tumour that were died on 11^{th} and fifth day respectively. Damodaran (2004) reported that the general condition of dogs with urolithiasis was dull and lethargic.

5.9.3. Physiological Parameters

In both urolithiasis and cystitis cases, the variations observed in the physiological parameters were within normal range. In case of prostatic abscess, and

bladder tumour pyrexia was observed. According to Kutzler and Yeager (2005) and Rubin (1990b), fever was observed in dogs with prostate abscess.

5.9.4. Catheterization

Catheter could not be passed beyond the middle of os-penis in five cases. Catheter could be passed up to the level of os penis in two cases. Catheterization was feasible up to the urethra at the level of ischial arch in one dog.

5.9.5. Urinalysis

Urinalysis was conducted using uristick. Reine and Langston (2005) reported urine dipstick was a convenient method for biochemical analysis of urine.

5.9.5.1. Physical Examination

5.9.5.1.1. Colour: In case of urolithiasis, only one dog (A1) had red coloured urine (haematuria), two had dark yellow urine (A4 and A6) and others had pale yellow urine on the day of admission. The colour of urine was pale yellow in all dogs on day seventh except in A1 where the colour was dark yellow. On 21st day, in all cases the colour of urine was pale yellow. Hoff (1986), Abdullahi and Adeyanju (1987) and Varshney *et al.* (1988) reported red coloured urine with urolithiasis cases.

Out of five cases of cystitis, four dogs had (A7, A8, A9, and A10) red coloured urine and others had pale yellow coloured urine. The colour of urine was changed from red to pale yellow after treatment in all dogs except in dog A7 in which the colour remained red on seventh day of treatment.

Distension of the urinary bladder could have lead to the disruption of the inflammed mucosal lining, and the resultant bleeding may be responsible for the reddish discoloration of urine and dark yellow urine may be due to retention of urine and increased concentration of urine. Hoff (1986), Abdullahi and Adeyanju (1987)

and Varshney *et al.* (1988) reported red coloured urine with urolithiasis. Rubin (1990a) and Bartges (2005) reported haematuria in dogs suffering from cystitis.

In dogs A12 and A13, the urine colour was red. The colour of urine was red on seventh day also in dog A12. Krawiec and Heflin (1992) Kutzler and Yeager (2005) reported haematuria in case of prostatic diseases. Straufuss and Dean (1975), Krawiec (1991) and Singh and Mohindroo (2007) reported haematuria in bladder tumour.

5.9.5.1.2. Transparency: The appearance of urine was turbid in all dogs except in A5 and A6(R) in which the appearance was clear. On 7th day, the appearance of urine was clear in all cases except two cases (A7 and A12). The appearance was clear in all dogs on 21st day.

According to Hoff (1986) and Varshney *et al.* (1988) urine was turbid in urolithiasis and Rubin (1990) and Bartges (2004) reported turbid urine in cystitis.

5.9.5.1.3. pH : In all cases on the day of presentation pH was acidic which changed to alkaline on the day seven due to the administration of urinary alkalanizers and were changed to normal acidic pH on 21st day. Hoff (1986) and Varshney *et al.* (1988) reported alkaline pH associated with struvite urolithiasis. Osborne *et al.* (1981) reported alkaline pH associated with struvite and apatite calculi, acidic pH with cystine and variable pH with ammonium urate, calcium oxalate and silica. Adams and Syme (2005) reported acidic pH in calcium oxalate calculi, ammonium urate, xanthine and cystine calculi.

In the present study, in all cases of cystitis the organism isolated was *E. coli* and pH of urine was acidic. Bartges (2005) reported pH of urine as acidic in *E. coli* infection and alkaline in staphylococcal infection.

5.9.5.1.4. Specific gravity: Specific gravity of the urine was within normal range in cases except in case of prostate abscess and bladder tumour where there was low specific gravity. In both cases, there was renal failure and impaired renal concentrating and diluting ability might have resulted in acute renal failure resulted in low urine specific gravity between 1.008 and 1.018 as reported by Cowgill and Francey (2005).

5.9.5.2. Chemical Examination: Proteinuria was observed in all cases before treatment but the condition was inappreciable after treatment. This is in accordance with Hoff (1986) and Abdullahi and Adeyanju (1987), and Varshney *et al.* (1988). Rubin (1990a) reported proteinuria in cystitis cases.

In dogs A12 and A13, severe proteinuria (+++) and (++++) respectively was observed on the day of presentation. In both cases, there was renal failure. Cowgill and Francey (2005) reported proteinuria in most ureamic cases. According to Rubin (1990a) proteinuria results from leakage of serum proteins into the urinary tract at sites of haemorrhage or exudation. Bartges (2005) reported proteinuria in bladder tumour cases.

5.9.5.3. Microscopic examination of urine sediments: Microscopic examination of urinary sediments revealed the presence of calcium oxalate crystals in A1, A2 and A4 only and the crystals were appeared as small and colourless square envelopes. No crystals were detected on seventh and 21st day. Osborne *et al.* (1986) described calcium oxalate dehydrate crystals appeared in urine as small, colourless envelopes (octahedral form) and calcium oxalate monohydrates as small spindles, hemp seeds or dumbbells, appeared as colourless, three to six sided prisms. According to Adams and Syme (2005) calcium oxalate dihydrate crystals appeared as square envelops.

In dogs A1, A7, A8, A9, A10, A12 and A13 had haematuria at the time of admission and the number of erythrocytes per high power field was high. After

treatments, on 7^{th} and 21^{st} day normal levels of erythrocytes per high power field were observed in all dogs. The dog A7 had erythrocytes in urine even after treatment and A12 and A13 were died during the course of treatment. Hoff (1986), Abdullahi and Adeyanju (1987) and Varshney *et al.* (1988) reported elevated number of erythrocytes per high power field in urine of dogs with urolithiasis. Rubin (1990a) and Bartges (2004) reported more number of erythrocytes per high power field in urine of dogs with cystitis. Krawiec and Heflin (1992) and Kutzler and Yeager (2005) reported more number of erythrocytes per high power field in urine of dogs in case of prostatic diseases. Straufuss and Dean (1975), Krawiec (1991) and Singh and Mohindroo (2007) reported more number of erythrocytes per high power field in urine of dogs in bladder tumour.

All the dogs showed pus cells in urine sediment on the day of presentation except A5. After treatment, on 7^{th} and 21^{st} day normal levels of pus cells per high power field were detected. Hoff (1986), Abdullahi and Adeyanju (1987) and Varshney *et al.* (1988) reported pyuria in urolithiasis cases. Rubin (1990a) and Bartges (2004) reported pyuria in cystitis cases. Goett and Degner (2003) reported pyuria in bladder tumour cases. Reine and Langston (2005) reported pyuria in prostatic diseases.

Epithelial cells were within normal range. But according Reine and Langston (2005) increased numbers of epithelial cells were seen in infection, inflammation, irritation, and neoplasia. According to Hoff (1986) and Varshney *et al.* (1988) epithelial cells were present within urine of urolithiasis cases.

Microscopical examination revealed the presence of calcium oxalate crystals in three dogs. Osborne *et al.* (1986) detected crystalluria in urolithiasis cases.

5.9.6. Culture and sensitivity test of urine samples

In dogs with urolithiasis, the organism isolated were Streptococci spp in three cases, Staphylococci spp two cases, and *E.coli* in one case. According to Brown *et al.* (1977b), Case *et al.* (1993) and Ling *et al.* (1998a) in urolithiasis, the most frequently isolated organism was Staphylococci spp where as according to Brown *et al.* (1977a) and Clark and Panciera (1992) the organisms isolated were *E. coli*, Streptococci, Staphylococci and Proteus spp. Varshney *et al.* (1988) isolated *E. coli* in a urolithiasis case.

The antibiotic ciprofloxacin was sensitive in all cases of urolithiasis. According to Shaw (1990) fluroquinolone antibiotics offered some important advantages such as broad spectrum antibacterial activity, prostatic tissue penetration, and high urine concentration. Damodaran (2004) reported ciprofloxacin followed by ampicillin and amoxycillin in order of sensitivity in urolithiasis cases.

In all cases of cystitis, the organism isolated was *E. coli.* According to Oxenford *et al.* (1984), Shaw (1990), Rubin (1990a) and Bartges (2005) the most common pathogen that cause urinary tract infection is *E. coli* and other species that cause urinary tract infection are Staphylococcus, Streptococci and Proteus spp. The antibiotics sensitive were ciprofloxacin, pefloxacin, enrofloxacin, gatifloxacin, cefotaxime and ceftriaxone.

In dog A12, on culture and sensitivity test revealed *E. coli* and the colony count was more than one lakh colony forming unit/ml and the sensitive antibiotics were ciprofloxacin, enrofloxacin, gatifloxacin, pefloxacin and cefotaxim. Enrofloxacin at the dose rate of 5mg/kg body weight was administered intramuscularly for seven days but not responded to the treatment. Kutzler and Yeager (2005) reported the most common pathogen that causes prostatitis as *E.coli*.

The dog A13 with bladder tumour, the organism isolated was Staphylococcus and the colony count was more than one lakh colony forming unit/ml and the sensitive antibiotics were ciprofloxacin, amoxycillin, enrofloxacin and gatifloxacin. This is in agreement with Oxenford *et al.* (1984) and Krawiec (1991) who reported concomitant urinary tract infection associated with bladder tumour.

5.9.7. Prostate Fluid Analysis

In one case with prostate abscess, the urethral discharge showed numerous neutrophils. Rubin (1990b) reported neutrophils in prostatic fluid of dogs affected with bacterial prostatitis.

5.9.8. Haematological Parameters

5.9.8.1. Total erythrocyte count (TEC): The total erythrocyte count (10^6/cu.mm) on seventh and 21st day revealed increase from pre treatment value and was within normal range. Osborne *et al.* (1985) and Sinha *et al.* (1986) reported the same in cases with urolithiasis. The total erythrocyte count was low in dog A13 with bladder tumour. Singh and Mohindroo (2007) reported anaemia in bladder tumour due to constant blood loss.

5.9.8.2. Haemoglobin concentration: The haemoglobin concentration (g/dl) was found to be slightly less than normal before the surgery and returned to normal on seventh and 21st day after surgery in urolithiasis cases. This is in accordance with Osborne *et al.* (1985) and Sinha *et al.* (1986). The reduction in haemoglobin content before surgery may be attributed to haemorrhagic cystitis arises due to uroepithelial irritation.

The haemoglobin concentration was less than normal on first day and returned towards normal on 21st day after treatment in cases with cystitis. The reduction in haemoglobin level may be due to haematuria and haemorrhagic cystitis.

The haemoglobin level of dogs with prostatic abscess and bladder tumour was found to be very low. This may be due to haematuria. Singh and Mohindroo (2007) reported anaemia in bladder tumour due to constant blood loss.

5.9.8.3. Volume of Packed Red Cell (VPRC): The mean volume of packed red cells (%) was found to be reduced but within normal range on the day of surgery in urolithiasis and was found to be increased on 21st day. Osborne *et al.* (1985) and Sinha *et al.* (1986) reported low level of VPRC in urolithiasis.

The mean volume of packed red cell (%) was found to be less than normal before treatment and returned towards normal on 21st day in cystitis cases.

The volume of packed red cell (%) was found to be low in both in prostatic abscess and bladder tumour cases.

5.9.8.4. Total leukocyte count (TLC): In both urolithiasis and cystitis cases, the total leukocyte count (10^3 cells /cu.mm) was observed to be high before treatment and reduced considerably towards normal on 21st day. Lulich *et al.* (1991), Sharma *et al.* (2005) and Verma *et al.* (2006) reported leukocytosis with neutrophilia in urolithiasis. In dogs with prostatic abscess, the total leukocyte count with neutrophilia was observed. This is in agreement with Barsanti and Finco (1986) and Rubin (1990b).

5.9.8.5. Differential Leukocyte count (DLC): The mean neutrophil count (%) was observed to be high before treatment and returned towards normal on both seventh and 21st day of treatment. Lulich *et al.* (1991), Sharma *et al.* (2005) and Verma *et al.* (2006) reported neutrophilia in urolithiasis patients.

In both prostatic abscess and bladder tumour cases, neutrophil count was very high. Singh and Mohindroo (2007) reported neutrophilic leukocytosis in bladder tumour. Barsanti and Finco (1986) reported neutrophilia in dogs with prostatic abscess.

The thrombocyte count was done in dog A13 with bladder tumour and was found to be very low. The count was 5000 cells/µl instead of normal two lakh to four lakh cells /µl. According to Gaschen and Teske (2005) reported thrombocytopenia was the one of the most common haemostatic abnormalities in cancer patients and the life span of the platelets could be shortened, especially with metastatic tumour

5.9.9. Biochemical Analysis

5.9.9.1. Blood Urea Nitrogen (BUN): The blood urea nitrogen level was found elevated in all dogs before surgery in case of urolithiasis and returned to normal on 21st day. The increase of BUN in urolithiasis cases is in agreement with the findings of Varshney *et al.* (1988), Benjamin (2005), Sharma *et al.* (2005) and Verma *et al.* (2006). The increase in the BUN may be due to retention of urine resulting in increased absorption of abnormal metabolic products due to obstruction of the urethra. The blood urea nitrogen level was within normal range in dogs with cystitis. Rubin (1990a) reported that in most cases of cystitis and urethritis, there was no change in blood biochemistry.

The blood urea nitrogen was significantly elevated in both prostatic abscess and bladder tumour cases. An increase in BUN and creatinine values in renal failure was reported by Benjamin (2005).

5.9.9.2. Serum creatinine: The mean serum creatinine level (mg/dl) was slightly elevated but within normal range before treatment and reached normal on 21st day in both urolithiasis and cystitis cases. According to Benjamin (2005), Sharma *et al.* (2005) and Verma *et al.* (2006) there was elevation in serum creatinine level in urolithiasis. Rubin (1990a) reported that there was no change in blood biochemistry in cystitis and urethritis.

The serum creatinine level was found to be very high in both bladder tumour and prostate abscess cases which may be due to nephritic changes.

5.9.9.3. Serum sodium: The serum sodium level (mEq/L) was found to be less than normal on before surgery and reached normal on 21st day in urolithiasis. This is in accordance with Benjamin (2005). The serum sodium level was within normal range in cystitis cases. The serum sodium level was found to be very low in both prostatic abscess and bladder tumour cases. Benjamin (2005) and Cowgill and Francey (2005) reported hyponatraemia in renal failure.

5.9.9.4. Serum potassium: In dogs with urolithiasis, the serum potassium level (mEq/L) was found to be elevated before surgery that attained normal level by 21st day. This is in accordance with Lipscomb (2003) and Hall *et al.* (1987) where they reported mild hyperkalemia in urolithiasis. The serum potassium level was within normal range in cystitis cases. The serum potassium level was highly elevated both in prostatic abscess and bladder tumour cases. In both cases there was renal failure and severe hyperkalemia. Cowgill and Francey (2005) reported hyperkalemia was a common and life threatening electrolyte disorder in acute ureamia.

5.9.10. Out come of treatment

In cases of urolithiasis and cystitis, all dogs were cured except two dogs (A1 and A6) showed recurrence of the condition. The dogs A12 and A13 died on 11th and fifth day of treatment respectively due to renal failure. In dog A11, urinary incontinence still persists after curing the cystitis.

5.9.11. Calculi Analysis

Of the eight cases, calcium oxalate was the major component in six dogs (A1, A1 (R), A2, A3, A4 and A5) and calculi in cases A1 and A1 (R) were contained calcium carbonate also. In dogs A3, A4 and A5, in addition to calcium oxalate uric acid was also present. The uroliths in two dogs A6 and A6 (R) were composed of calcium phosphate and uric acid. The uroliths in dog A2 were composed of calcium oxalate only. This was in accordance with Singh *et al.* (2005) and the authors

reported calcium oxalate as the most predominant type of calculi followed by calcium carbonate phosphate and magnesium ammonium phosphate. Lulich *et al.* (1991) and Ling *et al.* (1998c) reported the struvite calculi were the most predominant type of calculi in dogs followed by calcium oxalate uroliths. Sosnar *et al.* (2005) reported that occurrence of calcium oxalate calculi was continuously increased from 26.5 per cent in 1997 to 44 per cent in 2002.

The calculi were light tan in A1 and A1(R), medium tan in A6 and A6(R), dark tan in A4, grey in A2 and A3 and green in A5. The shape of calculi was round and ovoid in A1 and A1(R), rosette shaped and faceted in A2, ovoid in A3, jack stone in A4, both faceted and ovoid in A5, faceted in A6 and pyramidal in shape in A6(R). In the present study the calculi from dog A5 was green in colour and the calculi was composed of calcium oxalate and uric acid. Weichselbaum *et al.* (1998) described the colour of urate calculi as green. In dog A2, few calculi were rosette shaped. This is in accordance with the report of Weichselbaum *et al.* (1998). In dog A4, the shape of the calculi was jack stone shaped and calculi composed of calcium oxalate and uric acid. Osborne *et al.* (1986) and Adams and Syme (2005) reported that the jack stone shape is typically seen in silica urolith and occasionally in case of calcium oxalate uroliths.

Summary

SUMMARY

The study was conducted in 15 cases of lower urinary tract disorders in 13 dogs of different breeds, age and either sex presented at Veterinary College Hospital, Mannuthy and University Veterinary Hospital, Kokkalai.

Of the 13 dogs studied, six dogs had urolithiasis, (A1, A2, A3, A4, A5, and A6), five dogs had cystitis (A7, A8, A9, A10, and A11) and one had urinary incontinence due to prostatic abscess (A12) and one bladder tumour (A13). Of the six dogs with urolithiasis, two dogs (A1 and A6) showed recurrence after 25 days and three months were numbered as A1 (R) and A6 (R) respectively and studied as two separate clinical cases.

Among the six dogs studied with urolithiasis, two were Dachshunds, one each was Labrador, Spitz, Boxer, and Samoyed. Out of five dogs affected with cystitis, two were Dachshunds, and one each was Labrador, Rottweiler and German Shepherd Dog. The dog affected with prostatic abscess was a German Shepherd Dog and bladder tumour was Cocker Spaniel.

The age of dogs studied ranged from 3.5 to 10 years in urolithiasis and five to 10 years in cystitis. The age of dog with prostatic abscess was nine years and bladder tumour was 10 years.

All the dogs affected with urolithiasis were males. Out of five dogs affected with cystitis three were males and two were females. The dog affected with bladder tumour was male.

At the time of presentation, the general condition of all dogs with urolithiasis were dull and lethargic. Among five dogs with cystitis, three dogs were active (A7, A8 and A9), one was dull and lethargic (A11) and one was weak and recumbent

(A10). The dogs A12 and A13 suffering from prostatic abscess and bladder tumour were weak and recumbent. Colour of mucous membrane was congested in all dogs except in A7 and A12. All the dogs showed difficulty in urination (dribbling) except three (A7, A8 and A9) and bladder distension was detected in all dogs except in two (A8 and A9). Vomiting was showed by five dogs (A1, A1(R), A2, A11 and A13) and haematuria by seven dogs (A1, A7, A8, A9, A10, A12 and A13). In dog A12, rectal palpation revealed prostatic enlargement and other clinical signs like dyschezia, fever, urethral discharge and caudal abdominal pain were present.

Lateral radiograph of abdomen revealed distension of bladder in all dogs except in A9. In dogs with urolithiasis, out of eight cases, including two recurrences, the survey radiography revealed the presence of calculi were in the ventral groove of os penis in three cases (A2, A3 and A6), posterior to the os penis in one case (A4) and at ischial arch of the urethra in one case (A1(R). Calculi with in the urinary bladder were detected in three cases (A1(R), A3 and A6) and in A9 tiny cystic calculi were detected. Positive contrast urethrography revealed the presence of radiolucent calculi in the groove of os penis in A5 (confirmed on surgery) and behind the os penis in A6 (R). In dogs with cystitis, thickening of the bladder wall was noticed in A7 only while in others bladder wall thickening was not evident in survey radiography.

Contrast radiography was proved to be a highly useful tool for diagnosing intraluminal filling defect such as bladder tumour and blood clot. In dogs A7 suffering from cystitis, on double contrast cystography, intraluminal filling defect within the bladder was observed and in A13, on positive contrast cystography intraluminal radiolucent filling defect within the bladder was observed.

Ultrasonography was a useful tool for diagnosing all types of lesions in bladder, urethra and prostate and also useful in differentiating blood clot from tumour as hyperechoic mobile mass.

In dogs with calculi in bladder or in urethra, cystotomy or urethrotomy or both were conducted. For urethral calculi, urethrotomy was performed just behind the level of os penis (Prescrotal urethrotomy) in five cases (A1, A2, A3, A4 and A5). In dog A6 with urethral and cystic calculi, both urethrotomy and cystotomy was performed. In dog A6, recurrence of the calculi was observed after three months and was subjected to urethrotomy then.

Dogs with cystitis were treated with appropriate antibiotics based on the result of culture and sensitivity test and urinary alkalinizers. In cystitis cases, the treatment was initiated with ciprofloxacin at the dose rate of 10 mg/ kg body weight orally for three days. Then based on the culture and sensitivity test, antibiotic was changed if needed and administration of the antibiotic was continued for seven days. On absence of microbial growth on seventh day, the same antibiotic was continued for two more weeks. In presence of growth on seventh day, antibiotic was administered according to culture and sensitivity for next seven days, recultured the urine sample on seventh day and repeated the same procedure.

In the dog with prostatic abscess, enrofloxacin at the dose rate of five mg/ kg body weight was administered intramuscularly for seven days but not responded to the treatment. Later it developed renal failure and died. The dog with bladder tumour also developed renal failure and died on fifth day.

The study revealed that urethrotomy was found to be successful in removing urethral calculi in male dogs and cystotomy to remove large cystic calculi.

Catheter tolerance was poor in all dogs except A3 and in dog A3 the catheter was removed on the sixth day. Healing of the surgical wound was good in all dogs. Swelling and slight oozing around the surgical site of cystotomy was noticed in dog A6.

Leukocytosis with neutrophilia was noticed in all dogs on the day of presentation. Decreased haemoglobin, packed red cell volume (VPRC) and total erythrocyte count were observed in all cases when they were initially brought for treatment. Blood urea nitrogen and creatinine values were slightly higher than normal in dogs with urolithiasis and were with in normal range in dogs with cystitis. Mild hyponatraemia and hyperkalaemia was observed in dogs with urolithiasis. In prostatic abscess and bladder tumour there was severe hyponatreamia and hyperkalaemia. The thrombocyte count was found to be very low in dog with bladder tumour.

Out of eight cases of urolithiasis, only one had red coloured urine (haematuria) and urine was turbid in all cases except in two. The pH of all the urine samples were acidic on the day of presentation. Proteinuria was observed in all cases before treatment but the condition was inappreciable after treatment. In dogs A12 and A13 severe proteinuria was observed (+++) and (++++) on the day of presentation. Microscopic examination of urinary sediments in dogs (A1, A2 and A4) revealed the presence of calcium oxalate crystals on the day of presentation.

The organism isolated in dogs with urolithiasis was Streptococci spp in four cases Staphylococci spp and *E.coli* in one each. The antibiotic sensitive in all cases except one was ciprofloxacin. Amoxycillin was sensitive in one case. In all dogs with cystitis, the organism isolated was *E. coli* and the antibiotics sensitive were ciprofloxacin, pefloxacin, enrofloxacin, gatifloxacin, cefotaxime and ceftriaxone, amikacin in three cases and along with these chloramphenicol and nitrofurantoin in one case each.

Of eight cases, calcium oxalate was identified as major component in six dogs (A1, A1 (R), A2, A3, A4 and A5) and calculi in dogs A1 and A1 (R) were composed of calcium carbonate also. In dogs A3, A4 and A5, in addition to calcium oxalate, uric acid was also present. The uroliths in two dogs A6 and A6 (R) were composed

of calcium phosphate and uric acid. The urolith in dog A2 was composed of calcium oxalate only.

From the study following conclusions were drawn.

Urolithisis was the most common disease (53%) among the 15 cases of diseases of the lower urinary tract in dogs followed by cystitis (33.33%).

Middle aged dogs were mostly affected with urolithiasis and cystitis and the age of incidence of urolithiasis was seven years and cystitis was 6.8 years.

Urolithiasis was more common in male dogs than in females.

Dachshund was the most common breed affected with both urolithiasis and cystitis.

The cause of urethral obstruction was mostly urolithiasis and the common site of obstruction was the ventral groove of os penis.

Survey radiography was highly successful (75%)in the detection of most of the calculi.

Contrast radiography was useful in the detection of radiolucent calculi, space occupying lesions like blood clot and bladder tumour.

Ultrasonography along with radiography forms a highly useful tool in arriving at a confirmatory diagnosis.

Prescrotal urethrotomy was found to be effective in relieving urethral obstruction in the groove of os penis and post os penis level.

Cystotomy was required to remove large calculi within the urinary bladder.

Healing of the surgical wound was good in open urethrotomy wound.

The major microorganism associated with urolithiasis was Streptococci and cystitis was *E.coli.*

Most sensitive antibiotic was ciprofloxacin in case of urolithiasis and cystitis.

The chemical analysis of the calculi revealed calcium oxalate as the major component followed by uric acid.

Calculi composed of calcium oxalate, calcium carbonate and uric acid were mostly associated with Streptococcal infection and calcium phosphate and uric acid were associated with Staphylococcal infection.

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RADIOGRAPHIC EVALUATION AND MANAGEMENT OF LOWER URINARY TRACT DISORDERS IN DOGS

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ABSTRACT

The study was conducted in 15 cases of lower urinary tract disorders in 13 dogs of different breeds, age and either sex presented at the Veterinary College Hospital, Mannuthy and University Veterinary Hospital, Kokkalai.The incidence, clinical signs, radiographic and ultrasonographic observations, haematological and biochemical changes, treatment adopted, and post operative management in surgical treatment were studied.

Urolithiasis was the most common disease (53%) among the 15 cases of diseases of the lower urinary tract studied followed by cystitis (33 %), urinary bladder neoplasia (6%) and prostate disease (6%).

Dachshund was the most common breed affected with both urolithiasis and cystitis. Middle aged dogs were mostly affected with urolithiasis and cystitis

The general conditions of all dogs with urolithiasis were dull and lethargic. Congesion of mucous membrane, Vomiting,haematuria, reduced food intake, dribbling of urine and abdominal distension were the common symptoms exhibited.

The cause of urethral obstruction was mostly urolithiasis and the common site of obstruction was the ventral groove of os penis.

Survey radiography was highly successful (75%) in detection of most of the calculi. Contrast radiography was useful in the detection of radiolucent calculi, space occupying lesions like blood clot and bladder tumour. Ultrasonography was highly useful tool for confirmatory diagnosis of cystic calculi, cystitis, prostatic abscess and space occupying lesions.

In dogs with calculi in bladder or in urethra, cystotomy or urethrotomy or both were conducted. For urethral calculi, prescrotal urethrotomy was performed in five

cases. In a case with urethral and cystic calculi, both urethrotomy and cystotomy were performed. Recurrence of the condition was noticed in two dogs, one after 25 days due to the obstruction of urethra at the level of ischial arch and was then subjected to cystotomy after retrohydropropulsion into the bladder. In other dog, recurrence of the calculi was observed after three months and was subjected to urethrotomy then.

As per culture and sensitivity test, the major microorganism associated with urolithiasis was Streptococci and with cystitis, it was *E.coli.* Most sensitive antibiotic was ciprofloxacin in cases of urolithiasis and cystitis.

On analysis of uroliths, calcium oxalate was found to be major component followed by uric acid. Calculi contained calcium oxalate, calcium carbonate and uric acid were mostly associated with Streptococcal infection and with calcium phosphate and uric acid the organism isolated was Staphylococci.