# EVALUATION AND MANAGEMENT OF UROLITHIASIS IN DOGS

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Thesis submitted in partial fulfilment of the requirement for the degree of

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## DECLARATION

I hereby declare that the thesis entitled **"EVALUATION AND MANAGEMENT OF UROLITHIASIS 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 **"EVALUATION AND MANAGEMENT OF UROLITHIASIS IN DOGS"** is a record of research work done independently by **Ms. Reshma Damodaran**, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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***Reshma Damodaran***

# CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# *Introduction*

# INTRODUCTION

The urinary system in animals is a unique organ system vested with functions which are of unusual combination. In the broadest concept it is a system concerned with excretion of metabolic end products in soluble form. However, some of the waste products are sparingly soluble and occasionally precipitate out of solution to form crystals.

Urolithiasis may be defined as the formation of calculi from less soluble crystalloids of urine as a result of multiple congenital or acquired physiological or pathological process. If such crystalloids become trapped in the urinary system they may grow to sufficient size to cause clinical signs. The predisposing causes of urolithiasis include: a high degree of urinary super saturation, reduced urinary inhibition of crystal growth and prolonged particle transit time in urine. The most common type of urolith found in dogs is magnesium ammonium phosphate or struvite. Uroliths containing ammonium and urate, uric acid, calcium phosphate and calcium oxalate occur less frequently (Osborne *et al.*, 1985).

Urethral calculi are common in male dogs, the presenting signs being pollakiuria, dysuria, tenesmus, haematuria, incontinence and distended bladder. Cystic calculi causes signs of lower urinary tract inflammation with pollakiuria, dysuria, tenesmus and haematuria (Brodey, 1955).

Medical management of urolithiasis either in the bladder or urethra are carried out by giving calculolytic drugs. Incomplete blockage of the urethra may be treated by medical and dietary management but requires prolonged care. Hydropropulsion of the urethral calculi into the bladder may temporarily relieve the condition but recurrence within a short period occurs due to the migration of cystic calculi into the urethra causing partial or complete blockage. Hence surgical removal of the calculi is the ideal method of treatment.

The data on incidence of urinary obstructions in the Veterinary Hospitals of College of Veterinary and Animal Sciences was analysed and found that the incidence was high in dogs and not many report of detailed studies of the cases are available from this state.

A study on the type or composition of the calculi would help in understanding the nature of calculi present and to give suitable medicinal and dietary management in operated animals to prevent recurrence. Hence the work was undertaken to study the etiology and pathology of urolithiasis in dogs and to evaluate the surgical treatment and post operative management.

# *Review of Literature*

# REVIEW OF LITERATURE

## INCIDENCE

### Age

Brodey (1955) reported that the age of incidence in calculi formation in dogs varied from four month to fourteen years.

Weaver (1970) studied 100 cases of canine urolithiasis and found that the mean age of occurrence of phosphate calculi was 5.3 years, oxalate 8.3 years, cystine 4.5 years. Incidence of oxalate calculi was more in older age group whereas phosphate and urate were seen in younger ones.

Clark (1975) found that the mean age of dogs with magnesium ammonium phosphate calculi was six years, with calcium calculi 8.6 years and for cystine calculi 4.9 years.

Brodey *et al.* (1977) after analyzing 293 necropsy cases, reported that the mean age of dogs affected with silicate urolithiasis as two years.

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 the type of calculi, viz., phosphate calculi - six years, cystine - 4.8 years, urate - 5.5 years, oxalate - 7.8 years and for those with carbonate 12.3 years.

Osborne *et al.* (1981a) reported that the mean age of dogs with silica urolithiasis was 5.8 years within a range of 1.5-12 years.

Osborne *et al.* (1990) reported that metabolic uroliths (calcium oxalate, calcium phosphate and cystine urolith) were commonly encountered in immature dogs.

Case *et al.* (1992) reported that the mean age at first episode of cystine urolithiasis was approximately four to eight years.

Wallerstrom and Wagberg (1992) in a retrospective study of urolithiasis reported that urinary calculi were found at younger age in chondrodystrophic breeds than in well proportioned miniature dogs and large dogs.

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

Hesse *et al.* (1997) reported that stone formation in canines were predominantly observed at the age of seven years.

Ling *et al.* (1998a) analysed 11,000 specimens and found that the average age at diagnosis were 6.9 years in males and 6.47 years in females.

Ling *et al.* (1998b) reported that the mean age of dogs with urolithiasis as 6.67 years. Urate, cystine and struvite calculi were found in dogs with a mean age less than seven years whereas silica, brushite and oxalate calculi were seen in dogs with a mean age of seven years.

Ling *et al.* (1998d) analysed 11,000 specimens from different breeds of dogs and found that average age at diagnosis for Miniature Schnauzers, Dachshunds, Springer Spaniels, Chihuahuas, Maltese Terriers and Basset Hound were within the middle third of age. For mixed breed dogs, Miniature Toy poodles, Dobermann Pinschers, German Shepherd Dogs, Samoyeds and Cairn Terriers average age at diagnosis were at the older dogs.

Lulich *et al.* (1999a) analysed 24,263 calcium oxalate uroliths and found that the mean age of occurrence as 8.5 ± 2.9 years.

Lekcharoensuk *et al.* (2000) reported that middle aged castrated male dogs had increased risk for formation of calcium oxalate urolith and stated that urolith formation was also associated with increasing age.

Mok (2002) in a retrospective study of 30 cases found that cani urolithiasis occurred from one year to 12 years .The most prevalent age v three years.

Amarpal *et al.* (2004) reported the incidence of uroliths among Maximum number of cases were recorded in the age group of three to seven (42.8 per cent) followed by seven years (30.94 per cent), one to three (14.28 per cent), six to twelve months(4.76 per cent) and zero to six mont per cent).

**Breed**

Brodey (1955) reported that Cocker Spaniels were most affected by Dachshund, Dalmatian, Irish Terrier, Beagle, Scotish Terrier, Bosto Miniature Schnauzer, Collie, Chihuahua, Wire haired fox terrier an Shepherd Dog.

Finco and Rowland (1970) reported that the rate of occ urolithiasis was greater in Dachshunds, Dalmatians, Scottish Terriers Schnauzers, Pekingese and Cocker Spaniels than in Poodles, Labrad Shepherd Dog and Boxers.

Weaver (1970) studied 100 cases of urolithiasis and found tl Terrier was the most commonly affected breed followed by Mongre and Pekingese. Among the breeds, Cairn Terrier was affected with pl oxalate calculi, Dalmatian with urate, Basset Hound and Irish Terrier calculi.

Brown *et al.* (1977a) reported higher incidence of calculi formation in Miniature Schnauzer, Dachshund, Dalmatian, Pug, Bull dog, Welsh corgi, Beagle and Basset hound.

Schepper and Stock (1980) reported that the incidence of urolithiasis was more in Dalmatian (6.7 per cent) followed by Miniature Pinscher (2.6 per cent) and Dashchund (1.9 per cent).

Osborne *et al.* (1981a) reported that German Shepherd Dogs comprised more than one third of affected animals with silica urolithiasis.

Osborne *et al.* (1981b) reported high incidence of struvite urolith in Miniature Schnauzer and it was also reported to have a familial tendency.

Klausner *et al.* (1981) reported that Miniature Schnauzer have higher prevalence of struvite urolithiasis than other breeds.

Bovee and McGuire (1984) reported that Miniature Schnauzer, Welsh Corgi, Lhasa Apso, Yorkshire Terrier, Pekingese and Pug had significantly higher risk for urolithiasis compared with other breeds while German Shepherd Dog has significantly lower risk. Two breeds had significant relationship to a specific type of urolith, Miniature Schnauzer for oxalate and Dalmatian for urate.

Lewis and Morris (1984) reported that 60 per cent of uroliths encountered in adult male Basset Hounds, Bull dogs, Chihuahuas, Irish Terriers and Yorkshire Terriers were cystine. In males of other breeds 60 per cent of uroliths identified were phosphate.

Osborne *et al.* (1986) reported higher incidence of urolith in Miniature Schnauzer (22.3 per cent) followed by Miniature Poodle (10 per cent), Dachshund (5 per cent), Shih Tzu (5 per cent), Dalmatian (3 per cent) and Cocker Spaniel (3 per cent).

Hesse and Bruhl (1988) reported that Dachshund, Basset Hound and Irish Terrier had highest incidence of cystine urolith.

Osborne *et al.* (1989b) analysed 2700 uroliths removed from dogs and found that English Bull Dogs were more predisposed for the development of ammonium urate and cystine urolith.

Case *et al.* (1992) observed increased risk of cystine calculus in Mastiffs, Australian cattle dogs, English Bull Dogs, Chihuahuas, Bull Mastiff, New Found Hound, Dachshund, Basenji, Austrian Shepherd Dog, Scottish Deerhounds, Miniature Pinscher, Pit Bull Terrier, Welsh Corgis and Silky Terrier. Low risk of cystine urolith was found in German Shepherd Dog, Poodle, Schnauzers and mixed breed dogs.

Case *et al.* (1993) in a study of 275 cases found that the risk of forming urate containing calculi were high in Dalmatians, whereas the risk of forming calculi containing other minerals were consistently lower in Dalmatians than in other breeds.

Bartges *et al.* (1994) reported that urolith from Bull Dogs were composed of cystine which was 32.3 times greater than in Dalmatian.

Thilagar *et al.* (1996) reported highest incidence in non descript (30 per cent) followed by Pomeranian (17.7 per cent), Alsatian (16.2 per cent), Dobermann (7.7 per cent) and Labrador (7.7 per cent). The other breeds such as Sydney Silky Terriers, Dachshund, Boxer, Golden Retriever, Lhasa Apso and Dalmatian constituted 20 per cent.

Hesse *et al.* (1997) reported that small breeds such as Dachshund, Poodle, Terrier Schnauzer and Pekingese had greatest tendency to form stones. Ammonium urate crystals were found predominantly in Dalmatian (89.2 per cent), followed by Yorkshire Terrier (8.6 per cent), and Cocker Spaniel (4.6 per cent).

Aldrich *et al.* (1997) in a study of 773 cases found that female German Shepherd Dogs and old English Sheep Dogs were at increased risk for formation of silica containing urinary calculi.

Ling *et al.* (1998d) analysed 11,000 specimen and found Dalmatians, English Bull dogs, Cocker Spaniel and Pugs had higher prevalence of calculi containing urate. Cairn Terriers, Bichon Friese, Lhasa Apsos and Samoyeds had higher prevalence of oxalate calculi. Breeds with higher risk of silica urolithiasis were Shih-Tzu, Springer Spaniel, German Shepherd Dog and Doberman Pinscher. Dalmatian, Labrador Retrievers, English Bull Dogs, Cocker Spaniel and Golden Retrievers had low prevalence of calculi containing oxalate.

Jones *et al.* (1998) analysed canine and feline uroliths and found that the breeds with cystine calculi include Dalmatian, Basset Hound, Borzoi, New Found land, Shetland sheepdog, Labrador, Chihuahua, Fox terrier, English Bull Dog, Bichow Frise, Dobermann Pinscher and Border Collie.

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 Terrier and breeds with relatively lower likelihood of urocystolith included German Shepherd Dog, Shar-Pei, and German Short haired Pointer.

Franti *et al.* (1999) analysed 13,552 calculi from different places and found that Lhasa Apso, Yorkshire Terrier, Shih-Tzu, Basset hound, Pug, Mastiff, Bichon Friese, Doberman Pinscher, Dalmatian, English Bull dog and Pekingese had higher risk of renal lithiasis.

Lulich *et al.* (1999b) diagnosed 24,263 calcium oxlate urolith and found that the occurrence in Miniature Schnauzers as 24 per cent, Lhasa Apso 8.9 per cent, Yorkshire 8.3 per cent, Bichon Friese 6.3 per cent, Shih Tzu 5.7 per cent, Miniature Poodles 5.2 per cent and mixed breed 13.1 per cent.

Lekcharoensuk *et al.* (2000) reported that Miniature Schnauzer, Lhasa-Apso, Yorkshire Terrier, Bichon Frise, Shih-Tzu and Miniature and Toy Poodle had *increased risk* for developing calcium oxalate urolith.

Jones *et al.* (2001) reported that urate calculi occurred predominantly in Dalmatians. The breeds forming cystine calculi were Yorkshire Terrier, Rottweiller, Jack Russell Terrier, Labrador, Bull Mastiff and Basset Hound.

Mok (2002) in a retrospective analysis of 30 cases found that Miniature Schnauzer (6 cases), Maltese (5 cases) and Shih Tzu (4 cases) had higher incidence than other breeds.

Amarpal *et al.* (2004) reported that incidence of urolithiasis was maximum in Spitz (49 per cent) followed by non descript (21 per cent), Lhasa Apso (10 per cent), Pomeranian (7 per cent), Doberman (7 per cent) and Cocker Spaniel (3 per cent).

Houston *et al.* (2004) reported that mixed breeds with urolithiasis predominated followed by Shih Tzu, Bichon Frise, Miniature Schnauzer, Lhasa Apso, and Yorkshire terrier. Urate uroliths were most common in male Dalmatians.

**Sex**

Brodey (1955) reported that incidence of urolithiasis was more in males (27 out of 52) than in females. Occurrence of phosphate lithiasis was more in females and uric acid in males.

Finco and Rowland (1970) from clinical study of 133 urolithiasis cases in dogs reported that females were more affected (92) than males (41).

Clark (1975) reported that phosphate calculi were most common in females while males had more calculi composed of calcium salts or cystine.

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

Schepper and Stock (1980) in a retrospective study of 84 cases of urolithiasis reported that 80 per cent were males and 20 per cent were females.

Klausner *et al.* (1981) reported 60 per cent of struvite urolithiasis occurs in bitches at four to seven years of age.

Osborne *et al.* (1981a) encountered silica urolithiasis in 83 dogs out of which 81 were males and 2 females.

Lewis and Morris (1984) reported that more than 97 per cent of the uroliths occurred in males below one year of age.

Bovee (1986) reported that occurrence of cystine urolith was 53.4 per cent in males and 47.6 per cent in females.

Osborne *et al.* (1986) diagnosed 839 urolith and found that uroliths occurred more frequently in female dogs than in males. Struvite urolith occurred more in female dogs (72 per cent) than in male dogs (28 per cent).

Wallerstrom and Wagberg (1992) in a retrospective survey found that the distribution between sex were 57 per cent male and 43 per cent female in chondrodystrophic breeds, 74 per cent male and 26 per cent female in well proportioned miniatures, 83 per cent males and 17 per cent females in large breeds and 94 per cent male and 6 per cent females in Dalmatian.

Bartges *et al.* (1994) reported that male Dalmatians were 16.4 times more affected than females.

Thilagar *et al.* (1996) reported that incidence of urolithiasis was more in males (84.6 per cent) and less in females (15.4 per cent). In males single large sized urethral calculi were common in larger breeds while many small sized calculi were more in smaller breeds.

Hesse *et al.* (1997) reported that the incidence of stones formed in male dogs were twice as its occurrence in female dogs.

Jones *et al.* (1998) found that bitches of small breeds especially Welsh corgi and Bichon Frise were most frequently affected.

Weichselbaum *et al.* (1998) reported that in dogs about 94 per cent of urocystoliths produced in females or spayed females were magnesium ammonium phosphate whereas males and neutered males produced greater assortment.

Ling *et al.* (1998a) reported that struvite, apatite and urate containing calculi were more common in female dogs whereas oxalate, cystine, silica, brushite and xanthine containing calculi were more common in males. Mixed composition calculi were common in females.

Ling *et al.* (1998e) analysed 317 specimens of urinary calculi from renal origin and found that female dogs were at higher risk of developing renal calculi. Renal calculi from males were composed of urate and in females struvite and oxalate.

Lulich *et al.* (1999b) diagnosed 24,263 calcium oxalate uroliths of which 71.2 per cent were in males and 26 per cent were in females.

Lekcharoensuk *et al.* (2000) reported that male dogs had three times greater risk for developing uroliths than females. Neutered male dogs have 14 times greater risk for developing urolith compared with sexually intact female dogs.

Sharma *et al.* (2001) reported that incidence of obstructive urolithiasis were more in males due to greater length and narrower diameter of urethra.

Jones *et al.* (2001) reported that bitches of small breeds were more frequently diagnosed with struvite calculi. Male dogs more than 5 years of age were most frequently affected with oxalate calculi.

Mok (2002) analysed 30 cases and found that sex incidence were 63 per cent in males and 37 per cent in females.

## CLINICAL SYMPTOMS

Brodey (1955) reported haematuria, dysuria, increased frequency of urination pungent ammonical urine, pyuria, calculi in the urine and calculus anuria as the predominant signs of the lower urinary tract obstructions.

Klausner and Osborne (1979) reported haematuria, polyuria, polydipsia, listlessness and inappetence of seven months duration in a Great Dane presented with renal calculus.

Lulich *et al.* (1989) reported dysuria, anorexia, vomiting and depression in case of struvite urocystolithiasis.

Guly and Turney (1990) opined that if stranguria, dysuria, or complete anuria is observed, then post renal azotaemia secondary to lower urinary tract obstruction should be considered and that upper urinary tract obstruction should be considered in patients with abdominal pain, abdominal masses or a history of nephroliths.

Osborne *et al.* (1992) observed inappetence, apparent pain in the abdomen, urinary incontinence, slight haematuria, enlarged abdomen, foul odour of breath and injected scleral vessels in dogs with urethral calculi.

Schaer (1995) opined that any animal showing signs of mental depression, generalized muscular weakness, anuria, vomiting, diarrhoea and anorexia should be suspected for hyperkalaemia.

## HEMATOLOGY

Osborne *et al.* (1985) in urolithiasis cases noted that haemocrit, red cell count and haemoglobin concentration decreases and are directly related to each other.

Leucocystosis neutrophilia with a mild shift to left had been reported by Lulich *et al.* (1989) in urolithiasis.

Dogs exhibiting signs of chronic renal failure showed an increase in the number of reticulocytes, mean corpuscular volume, lymphocytes, neutrophils, and a decrease in the haematocrit and erythrocyte count and a degenerative right shift in the neutrophils as reported by Borku *et al.* (2000).

Benjamin (2001) reported that erythrocyte sedimentation rate increased with infection.

Sharma *et al.* (2001) observed uroepithelial irritation due to calculi and loss of red cells or haemoglobin in urine leading to lowered haemoglobin levels.

URINALYSIS

Klausner and Osborne (1979) in a case of struvite nephroliths affecting a Great Dane, observed alkaline urine, pyuria, proteinuria and presence of *Proteus mirabilus* in urine culture.

Grauer and Lane (1995) opined that increased urine turbidity or changes in urine sediment such as increase in the number of white blood cells, red blood cells, renal epithelial cells, or granular casts were indications of acute renal damage.

According to Bowles *et al.* (2000) urinalysis in cases of cystitis revealed proteinuria, hematuria and pyuria.

Borku *et al.* (2000) carried out analysis of urine from dogs exhibiting signs of chronic renal failure and revealed foul-odour, proteinuria, hematuria and decreased urine specific gravity. Microscopic examination of urine sediments demonstrated erythrocytes, leukocytes, epithelial debris, fat globules, phosphate crystals and mucous fibrils.

Benjamin (2001) opined that the consistency of urine may be cloudy due to the presence of epithelial casts, blood, leucocytes, bacteria, mucous and crystals.

SERUM BIOCHEMISTRY

Finco and Rowland (1970) stated that renal failure was the primary cause of hypercalcaemia along with other causes such as hyperparathyroidism and vitamin D toxicosis.

Osborne *et al.* (1990) reported that the patients with persistent obstruction due to uroliths had varying degrees of azotemia, hyperphospataemia, hypercalcaemia, hyperkalaemia and metabolic acidosis.

DiBartola (1995) opined that the blood urea nitrogen and creatinine concentrations would be elevated in renal disorders.

Schaer (1995) opined that hyperkalaemia could arise in cases of oliguria, anuria and in urinary obstruction.

Grooters (1997) reported that elevation in blood urea nitrogen and creatinine concentrations occurred in dogs with renal disorders.

Flegel *et al.* (1998) reported an increase in the blood urea nitrogen and creatinine in a Daschund dog affected with xanthine urolithiasis.

Benjamin (2001) reported an increase in blood urea nitrogen, serum calcium, serum phosphorus, potassium and a decrease in serum sodium in post renal urinary tract infections.

DIAGNOSIS

Brown *et al* (1977a) in a retrorespective analysis of 438 cases of canine urolithiasis found that most of the calculi were radiopaque and located in the bladder or bladder and urethra.

Fluckiger (1991) reviewed application of ultrasonography in clinical examination of the abdomen including examination of the liver, spleen, kidneys, prostate, uterus and bladder of dogs.

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

Voros *et al.* (1992) described that ultrasonography was of potential value in diagnosis of urinary tract disorders including neoplasia, cystic disease, chronic nephritis, congenital abnormalities, hydronephrosis and urolithiasis in dogs.

Indications of ultrasonography as a primary diagnostic technique which included discrimination of cystic and solid mass, exploration of fluid filled body cavities, discrimination of texture of solid mass and biopsy guidance (Cartee *et al.*, 1993).

Felkai *et al.* (1997) on ultrasound examination of the bladder found that calculi and blood clots were the two most common masses in the urinary bladder.

Ahmed *et al.* (1998) described ultrasonography as less invasive than contrast radiography in diagnosing chronic non suppurative nephritis, perirenal cyst, cystic kidney, renal calculus cystolisis, cystitis and diffuse peritonitis in dogs.

Ultrasonography of urinary bladder and ureter disorders were discussed by Penninck (1998).

Bumin and Temizsoylu (2000) suggested that simultaneous use of radiography and ultrasonography were helpful in diagnosing cystic calculi in dogs.

Rawlings *et al.* (2003) removed urinary calculi by laparoscopic assisted cystoscopy in three dogs and reported that it was minimally invasive and provided clear images of mucosal surface of the urinary bladder and proximal portion of the urethra for easy retrieval of urinary calculi.

SITE OF OBSTRUCTION

Brodey (1955) reported that of 23 males with urethral calculi, 16 had cystic stones as well. Of 19 males with cystic calculi 17 had multiple stones. One exception had a solitary uric acid stone which was associated with multiple pedunculated papillomas arising from the bladder epithelium. Of the 24 females with cystic phosphate calculi 22 had multiple pyramidal stones and two had solitary pitted stones.

Finco and Rowland (1970) stated that uroliths of the bladder or both the urethra and bladder predominated in a study of 133 clinical cases.

Archibald and Owen (1974) reported that the most common site of obstruction in male dog was at post os penis level of urethra.

Brown *et al.* (1977a) reported that most calculi were located either in the bladder or in the bladder and urethra. Phosphatic calculi were more commonly found in the bladder whereas cystine and urate calculi were more frequently located in the urethra.

Klausuer and Osborne (1979) reported a case of struvite nephrolith in a Great Dane dog.

Klausner *et al.* (1981) reported that struvite calculi occurred more frequently in bladder and were associated with staphylococcal infection.

Bovee and McGuire (1984) reported that urolith were predominant (73 per cent) in the urinary bladder. There was no significant relationship between anatomic site and type of urolith.

Osborne *et al.* (1985) reported that the common site of occurrence was at the urethra caudal to os penis.

Patil *et al.* (1992) reported that the calculi were lodged in the urethra in the region of os penis in a Dobermann dog.

Thilagar *et al.* (1996) reported the incidence of occurrence of calculi in urethra. Urethral obstruction post os penis (24.7 per cent) was the common site compared to obstruction at ischial arch (18.4 per cent), ventral groove of the os penis (9.2 per cent) and entire length of urethra (4.7 per cent).

Hesse *et al.* (1997) reported that 98 per cent of the stones were located in the lower urinary tract.

Ling *et al.* (1998a) reported that calculi were located in the urinary bladder of 93.1 per cent females and 79 per cent males and in the upper urinary tract of 4 per cent females and 2 per cent males. Calculi were found in multiple sites in 23.1 per cent males and 5.2 per cent of females.

Mok (2002) in a retrospective analysis of 30 cases found that the most prevalent anatomical location of calculi were in the urinary bladder and urethra in males and urinary bladder in females.

Nandi *et al.* (2003) studied the prevalence of urolithiasis and anatomical sites in dogs from Kolkata and found that prevalence of canine urolithiasis in the urethra and bladder was 19.51 per cent and 70.73 per cent respectively.

TYPE OF CALCULI

Brodey (1955) found that 80.76 per cent of dogs had phosphate calculi (either magnesium ammonium phosphate or calcium phosphate). Many of these calculi contained small amounts of fibrin, uric acid, cholesterol, oxalate and carbonate.

Finco and Rowland (1970) studied the composition of calculi and found that predominant mineral type was phosphate followed by cystine and oxalate in canines.

Weaver (1970) reported that in canine urolithiasis phosphate calculi were the common type (53 per cent) followed by oxalate (14 per cent), urate (13 per cent) and cystine (20 per cent).

Clark (1974b) studied the composition of calculi and found that phosphate was the main constituent (44 per cent) followed by oxalate (32 per cent), cystine (22 per cent) and urate (2 per cent). Recurrent calculi were composed of calcium or cystine (70 per cent), and magnesium ammonium phosphate (30 per cent).

Clark (1975) found phosphate was the main constituent (44 per cent), oxalate (32 per cent), cystine (22 per cent) and urate (2 per cent) of the cases and also reported that recurrent calculi have different composition from the original stones were staphylococcal infection occurs.

Clark (1976) studied the structure of calculi and on cross section found concentrically arranged laminar bands in magnesium ammonium phosphate and radial striation in ammonium urate calculi. Fissures were observed in the centre of calculi composed of ammonium phosphate.

Brown *et al.* (1977a) studied 438 cases of urolithiasis and found that 64 per cent of calculi were composed of phosphate, 27 per cent cystine, 5 per cent urate, 3 per cent oxalate and 1 per cent carbonate with the exception of a higher occurrence of urate calculi in Dalmatian.

Schepper and Stock (1980) reported the occurrence of four major typesof calculi, cystine (30 per cent), phosphate (25 per cent), oxalate (25 per cent) and urate (20 per cent). A predisposition was found for urate calculi in the male Dalmatian (11.9 per cent) and cystine in male Dachshund (3.1 per cent).

Osborne *et al.* (1981b) reported more frequent occurrence of struvite uroliths in the urinary tracts of dogs than other types of urolith. Infection of the urinary tract with urease producing bacteria especially staphylococci played an important role in urolith formation.

Rodgers *et al.* (1981) analysed calculi by multiple technique approach employing X-ray diffraction, infra red spectroscopy, scanning electron microscopy, X-ray fluorescence spectrometry, atomic absorption spectrophotometry and density gradient fractionation. The quantitative and qualitative results obtained showed excellent agreement.

Klausner *et al.* (1981) reported struvite as the major mineral component in 80 per cent of calculi analysed.

Lewis and Morris (1984) reported that the urolith in male Dalmatians was composed of urates. They reported that phosphate urolith formation was associated with *Staphylococcus aureus* urinary tract infection.

Bovee and McGuire (1984) analysed canine uroliths and found that the major type was struvite (69 per cent),followed by calcium oxalate (10 per cent), urate (7 per cent), silica (3.8 per cent), cystine (3.2 per cent ), calcium phosphate (1 per cent) and mixed (6 per cent).

Kobrink (1986) studied the composition of cystic calculi and reported that hexahydrate of magnesium ammonium phosphate was the most common type.

Osborne *et al.* (1986) analysed 839 uroliths and found that 69 per cent were compound urolith, 67 per cent struvite, 6.8 per cent calcium oxalate, 5.1 per cent urate, 5 per cent mixed, 3 per cent calcium phosphate, 2.9 per cent silica, 2.4 per cent cystine and 0.8 per cent matrix.

Hesse and Bruhl (1988) analysed 1731 samples of urinary calculi in dogs of which 389 calculi (22.5 per cent) were composed of cystine urolith .

Escolar *et al.* (1990) analysed 171 samples of canine urinary calculi and found that 46 per cent were struvite, 26 per cent cystine, 16 per cent whewettite 8 per cent urates, 3 per cent calcium phosphate and 1 per cent silica.

Escolar *et al.* (1991) analysed the composition and structure of calculi using infrared spectroscopy, scanning electron microscopy and energy dispersive X-ray. The infrared analysis showed that 45 per cent of the specimens were composed of pure cystine. The remainder contained calcium oxalate, struvite, calcium hydrogen phosphate dihydrate (Brushite) and complex urates. The examination of a series of selected samples by means of scanning electron microscopy and energy dispersive X-ray analysis complemented the infrared results.

Kruzik *et al.* (1991) analysed samples of 46 canine urolith and found that 2/3$^{rd}$ were phosphates and rest consisted of cystine, oxalate and urate. In some uroliths content of lead, cadmium, zinc, copper, chromium and nickel were detected.

Case *et al.* (1992) studied the composition of 102 cases of urolithiasis and found that cystine calculi accounted for 2 per cent of canine uroliths.

Case *et al.* (1993) examined 292 calculi from 275 Dalmatian dogs using polarised light microscopy and found that 193 were 100 per cent urate, 78 calculi contained more than or equal to 50 per cent urate in one or more layers and 14 calculi contained no urate. The secondary minerals most commonly encountered in mixed urate calculi were struvite (77 per cent) and oxalate (17 per cent).

Neuman *et al.* (1996) reported that the presence of small interconnected primary pores in struvite containing urinary calculi from dogs appeared to be a significant factor in determining the possible interaction of calculi changes in urine composition.

Senior and Kelly (1996) reviewed chemical composition and epidemiological incidence and found that the common form of stone was struvite followed by urate, cystine and calcium oxalate.

Hesse *et al.* (1997) analysed 5706 urinary stone from different areas of European countries and found that stones comprising struvite were more predominent (59.5 per cent), followed by cystine (15.5 per cent) calcium oxalate (14.2 per cent) and ammonium urate (5.0 per cent).

Aldrich *et al.* (1997) analysed silica containing urinary calculi obtained from 773 dogs by quantitative crystallographic technique and found that 535 specimenswere composed of multiple layers and 238 specimens with one mineral layer. Multiple layer calculi were composed of 80 per cent or greater silica (56 per cent) and 20-79 per cent silica (34 per cent). Most of one layer calculi were composed of 100 per cent silica (89 per cent).

Jones *et al.* (1998) found that struvite was the common urolith followed by oxalate and cystine.

Wenkel *et al.* (1998) in a retrorespective study of urinary calculi for 10 years found that the most of the urolith were composed of struvite or apatite, though calcium oxalate and cystine urolith also observed.

Ling *et al.* (1998c) reported that significant higher proportions of struvite, apatite and urate were found in urolith from females. Oxalate, cystine, silica and brushite were significantly more prevalent in males. 61 per cent of the specimens from males and 29 per cent from females were composed of a single mineral type. The most common mineral combination of two or more minerals included struvite and apatite. In 48 per cent specimens from males and 62 per cent specimen from females, the mineral formed several distinct layers of differing composition.

Franti *et al.* (1999) analysed 13,552 calculi from different places of the world and found that renal and ureteral calculi were most significant in South Atlantic region, whereas bladder and urethral calculi in South Central region.

Jones *et al.* (2001) analysed 156 uroliths by X ray diffraction and Infrared spectroscopy and found that 52 per cent were struvite followed by oxalate (25 per cent) and cystine (6 per cent).

Singh *et al.* (2001) analysed calculi removed from a Dobermann Pinscher and reported that struvite type had maximum percentage (65.80 per cent) as compared to apatite (25.5 per cent) and urate (8.70 per cent).

Mok (2002) analysed 30 cases of canine urolithiasis and found that the major mineral component was struvite (72 per cent). In male dogs out of 15 cases 10 were struvite and five were calcium oxalate. In female dogs eight out of 10 cases had struvite urolith.

Houston *et al.* (2004) studied the mineral composition of 16,647 uroliths and found that 43.8 per cent were struvite and 41.5 per centoxalate.Other types of uroliths, such as cystine, xanthine, silica and calcium phosphate were less common.

ORGANISMS ISOLATED

Finco and Rowland (1970) reported the isolation of Staphylococci from the urine of dogs affected with phosphate uroliths.

Clark (1974a) suggested that the presence of large number of cocci in most of the magnesium ammonium phosphate stones might be an important factor in the etiology of these calculi. Staphylococcal infection was more commonly associated with magnesium, ammonium and phosphate calculi than calcium stones. Recurrence of calculi formation was more seen in Staphylococcal infection.

Weaver and Pillinger (1975) reported that infection with a variety of bacteria including *Staphylococcus aureus, Staphylococcus epidermis, Streptococcus faecus, Escherichia coli* and Proteus species associated with the formation of phosphate calculi.

Brown *et al.* (1977a) studied 259 cases and found that the most common organisms isolated were Staphylococcus spp., Escherichia coli, Proteus spp., Streptococcus spp. and Klebseilla spp. which changed the pH of urine to alkaline.

Brown *et al.* (1977b) reported that out of 66 dogs tested for urinary infection 40 were positive. Among these dogs with phosphate calculi had Staphylococcus infections. The cultures from the cystine calculi had a wide range of bacteria.

Osborne *et al.* (1981b) reported that Staphylococcus was the most commonly found organism associated with struvite uroliths in dogs. Other organisms such as Klebsiella and Pseudomonas spp., eventhough had the potential to produce varying quantities of urease, they were not commonly associated with initiation of struvite urolith formation. Struvite uroliths could form in dogs within two to eight week following urinary tract infection with urease producing staphylococci.

Comer and Ling (1981) reported that bacterial contamination of urine occurred frequently when the specimen was collected by catheterisation or voided midstream catch. Bacterial contamination occurred more frequently in female dogs than male dogs.

Grodzki *et al.* (1981) determined lysozyme activity as an indicator of kidney damage in three cases of urolithiasis by agar gel diffusion test.

Bovee and McGuire (1984) reported that Staphylococcus and Streptococcus spp. were the most common isolates from urine samples affected with urolithiasis.

Lewis and Morris (1984) stated that uroliths associated with *Staphylococcus aureus* urinary infection were phosphate.

Case *et al.* (1985) isolated 51 coagulase positive staphylococcal organisms from canine urinary calculi and from the urine of dogs affected with urolithiasis.

Hoff (1986) performed quantitative and qualitative bacterial cultures from urine obtained by cystocentesis and isolated *Staphylococcus aureus* from the culture.

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

Dowling (1996) reported that *Staphylococcus intermedius* and *Escherichia coli* were most common pathogens associated with urinary tract infection and observed that Staphylococci were involved in the formation of struvite calculi in dogs and changing the pH to alkaline.

Ling *et al.* (1998d) analysed 11,000 specimens of urinary calculi (5781 from females, 5215 from males and 4 from unrecorded sex) and found that urolithiasis were associated with growth of bacteria isolated from urine or calculi or both in 65 per cent females and 44 per cent in males. The *Staphylococcus intermedius* isolated most frequently from either sex (54 per cent females, 30 per cent males) were responsible for alkaline urine.

TREATMENT

Brodey (1955) opined that acidifying drugs such as sodium acid phosphate and ammonium chloride could be used for urinary acidification . Enteric coated ammonium chloride (0.5 g/lb) is preferable as it is a better acidifier and it does not increase the renal excretion of phosphate as that of the sodium acid phosphate.

Osborne *et al.* (1983) described nonsurgical methods to remove uroliths from the urethra of female dogs by means of hydropropulsion.

Krawiec *et al.* (1984a) reported that administration of acetohydroxamic acid at a dosage of 25 mg/kg body weight of dogs with persistent urease positive urinary tract infection was effective in preventing urolith formation.

Krawiec *et al.* (1984b) reported that long term administration of acetohydroxamic acid to dogs with urease positive staphylococcal urinary tract infection and struvite urolithiasis resulted in dose dependent inhibition of urolith growth. Dose dependent adverse drug reaction included reversible haemolytic anaemia, abnormal red cell morphology and abnormality of bilirubin metabolism.

Waldron *et al.* (1985) found that suture closure of the urethra resulted in less haemorrhage and no stricture formation during the post operative recovery period.

Bovee (1986) suggested that the only effective treatment of cystine urolith was the use of D pencillamine at the dose rate of 30 mg per kg body weight daily in divided doses and also opined that for the treatment of cystine urolithiasis the initial step involved surgical removal of urolith from the urethra and bladder. The objective of medical therapy was to prevent recurrence of uroliths.

Hoff (1986) reported that restriction of protein levels in the food lowered the concentration of ammonium ions and urea in the urine which helped to acidify the urine.

Abdullahi and Adeyanju (1987) reported successful dissolution of ammonium urate urolith by the ultra low-protein diet and allopurinol. They also stated that combination of diet and allopurinol produce better result than the use of either alone.

Fettman (1988) opined that urinary acidifiers should be avoided since it may augment hypercalcaemia and helps in the formation of calcium oxalate uroliths.

Harshney *et al.* (1988) reported a case of cystic calculi in a bitch in which large cystic calculi were successfully removed by cystotomy.

Hesse and Bruhl (1988) reported that treatment with ascorbic acid for cystine urolithiasis was effective and stated that alpha mercapto propionyl glycine should be used in case of relapse.

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

Osborne *et al.* (1985) stated that a treatment of urolithiasis should include arresting further urolith growth, under saturation of urine with calculogenic crystalloids by increasing the solibility of crystalloids in urine, increasing volume of urine in which crystalloids are dissolved or suspended, changing urine pH to create an environment less favourable for crystallization, induction of diuresis, eradication of urinary tract infection and surgical approach.

Osborne *et al.* (1989a) reported that the efficacy of allopurinol depends on its hepatic conversion to oxypurinol. The efficacy of allopurinol in reducing the formation of uric acid may therefore be reduced in ammonium urate urolith forming patients with portovascular shunts.

Osborne *et al.* (1990) recommended that, to minimize the formation of xanthine the dosages of allopurinol should be considered in the context of the purine content of the animals diet. The authors succeeded in dissolving cystine urocystolith with a combination of dietary and pharmacological 2 MPG (2-mercaptopropionyl-glycine) therapy.

Lulich and Osborne (1992) studied the effect of chlorothiazide on urinary excretion of calcium in clinically normal dogs and suggested that chlorothiazide should not be recommended for treatment or prevention of canine calcium oxalate urolithiasis.

Ranganath *et al.* (1992) reported the incidence of an unusually large calcium oxalate cystolith in a bitch and its successful removal by cystotomy.

Hoppe *et al.* (1993) reported that 2 mercapto propionyl gycine (2-MPG) at a dose rate of 40 mg/kg body weight was a satisfactory alternative treatment of cystineuric dogs and had good prophylactic effect.

Senior and Kelly (1996) opined that struvite urolith may be associated with urinary tract infection which had to be controlled. As a part of treatment urine pH had to be lowered and urine volume increased by measures such as feeding low protein high sodium diet. They also reported that diets which lead to the dissolution of struvite stones have a low content of magnesium and phosphorus. They stated that urolith could be treated by feeding low proteins, xanthine oxidase inhibitors or induction of mild urinary alkalinisation. Cystine uroliths could be treated by drugs, feeding low protein, low sodium diet or by inducing alkaline urinary conditions and calcium oxalate uroliths by feeding diets which induced aciduria.

Newton and Smeak (1996) evaluated the effect of simple continuous closure of scrotal urethrostomy in 20 cases and reported that the mean durations of post operative active bleeding and mean duration of bleeding associated with urination were 0.2 and 3.1 day respectively.

Hesse *et al.* (1997) reported surgical treatment for 90 per cent of urethral calculi in male dogs.

Omprakash *et al.* (1999) in an experimental study found that suturing of urethral mucosa along with cavernosus spongiosum and tunica albuginea was better technique for management of urethrotomy wound in calves.

Makkena *et al.* (1999) described a case of cystic calculi in an eight year old Doberman bitch and its successful treatment by cystotomy.

Bhatt and Bijoor (2003) reported the use of successful Helical Stone Basket for the removal of multiple vesical calculi without surgical intervention of the bladder in male dogs.

COMPLICATIONS

Lewis and Morris (1984) reported that complications of urethrotomy were extravasation of urine, post surgical haemorrhage for up to 10 days and strictures of urethra. Urethrotomies required extensive after care as it might produce chronic cystitis, constipation and bladder atony.

Singh and Mirakhur (1993) reported retrograde migration of catheter into the urinary bladder, as a rare sequelae of urethral catheterization.

Newton and Smeak (1996) reported that long term complications of scrotal urethrotomy were intermittent urine scald, recurrent urinary tract infection and recurrent obstruction due to struvite stones. No complications due to wound dehiscence, stricture, incisonal infection, selfmultilation or incontinence were detected.

MANAGEMENT

Morris and Doering (1978) stated that in addition to medical and surgical treatment, dietary management is also an integral part of the total management regimen for recurrent canine urolithiasis.

*Osborne et al.* (1981a) opined that management of silica uroliths should include their removal from the urinary tract and eradication of associated urinary infection. Prophylactic measures reported included attempts to augment urine volume and change of diet.

Lulich *et al.* (1989) opined that dietary sodium, Vitamin C and Vitamin D should be avoided as it augmented hypercalciuria. They suggested that appropriate quantities of magnesium and pyrophosphate in urine might inhibit calcium oxalate crystalisation and aggregation. They also recommended to avoid excessive magnesium to dogs with calcium oxalate urolith because it may cause hypercalciurea.

Osborne *et al.* (1990) reported that two most common choices for management of urolithiasis in dogs were surgical removal or euthanasia.

Zentek *et al.* (1995) recommended that the cation-anion balance of the food was used as an important parameter to characterize the effects of a diet on urine pH, particularly in the formulation and declaration of dietetic foods.

Neumann *et al.* (1996) reported that the progress of dissolution from the calculus surface to the calculus interior was largely affected by the primary porosity originally present between crystals, forming the calculus framework. Apatite was more resistant in dissolution than struvite.

Lulich *et al.* (1999b) suggested after conducting a study that dietary sodium should be restricted when designing protocol to minimize calcium oxalate uroliths. They also suggested that to minimize calcium oxalate urolith formation in dogs acidifying drugs and diets should be avoided.

Saini *et al.* (2000) reported two cases of urolithiasis. In one case hydropropulsion was carried out and the calculi were removed by cystotomy. In the other hydropropulsion was not possible and hence urethrotomy was performed to remove the calculi.

Lekcharoensuk *et al.* (2000) observed decreased risk of urolithiasis in dogs fed on special diet for skin diseases.

Lekcharoensuk *et al.* (2001) suggested that diets formulated to contain higher protein, sodium, potassium, moisture, calcium, phosphorus and magnesium and with lower urine acidifying potential may minimize formation of calcium oxlate urolith in cat.

RECURRENCE

Ehrhart and Mc Cullagh (1973) reported that when given atherogenic diet, containing hydrogenated coconut oil 16 per cent, cholesterol 5 per cent, casein 20 per cent sucrose 29 per cent minerals and vitamins 3 per cent and non nutritive bulk 27 per cent (12 mg magnesium silicate and 48 g silicic acid ) increased the risk of silica urolithiasis and stated that such diet should not be given for long period to dogs.

Clark (1975) found that stones recurred with in two years in 75 per cent of the cases, where initial calculi were composed of calcium or cystine and 30 per cent with phosphate calculi.

Brown *et al.* (1977b) reported 111 cases of recurrence from a study of 438 cases of urolithiasis. The recurrent calculi were phosphate (54 dogs), cystine (45 dogs), urate (7 dogs), oxalate (3 dogs) and carbonate (2 dogs).

Idowu *et al.* (1983) reported that among 3675 dogs presented at the clinics for seven years in Ibadan, Nigeria only three cases of canine urolithiasis were recorded .The condition affected the urinary bladder and the urethra while the kidney and the ureters were not affected.

Bovee (1986) suggested therapeutic maneuvers to control recurrence of uroliths which included high fluid intake, alkalization of urine, reduced dietary protein intake and specific medication to inhibit urinary excretion of cystine.

Hoff (1986) reported that struvite calculi recurred in 17-30 per cent of the treatment managed by diet.

Osborne *et al.* (1990) reported that recurrence of urolith may be influenced by several variables which included persistence of underlying causes of urolithiasis, failure to remove all the urolith from the urinary tract including those inadvertently left behind and microlith that are too small to be seen, persistence of urinary tract infection with urease producing bacteria especially

*Staphylococci* and lack of compliance with therapeutic or prophylactic recommendations.

PREVENTION

Brodey (1955) opined that alumina carbonate gel can be used as prophylactic therapy as this binds with phosphorus in the digestive tract, lowered the in organic phosphorus which will reduce the renal excretion of phosphates.

Lewis (1989) reviewed dietary treatment of urolithiasis and opined that diet for urolithiasis should contain 8 per cent protein, 0.3 per cent calcium, 0.12 per cent phosphorus, 0.02 per cent magnesium and 1.2 per cent sodium in dry matter.

Osborne *et al.* (1992) recommended diet modification combined with administration of 2-mercepta propionyl-glycine for dissolution and prevention of cystine urolith in dogs.

Lekcharoensuk *et al.* (2002a) opined that dry diets containing high concentration of protein, calcium, phosphorus, magnesium, sodium, potassium and chloride may minimize the formation of calcium oxalate uroliths.

Sharma *et al.* (2001) reported haemorrhage from cavernous tissue and blockage of catheter due to blood clots and debris as the complication of urethrotomy.

OTHERS

Finco and Rowland (1970) stated that renal failure should be considered as a primary cause of hypercalcaemia along with other causes such as hyperparathyrodism and Vit D toxicosis.

Osborne *et al.* (1981b) reported that inbreeding resulted in unidentified hereditary function that predisposed them to uroliths formation. The incidence of struvite uroliths was 10.7 per cent in an inherited line of dogs compared with 2.0 per cent in an outbred line of dogs.

Klausner *et al.* (1987) reported that parathyroid adenomas were associated with calcium urolithiasis in two dogs.

Clark and Panciera (1992) reported a case of calcium phosphate urolithiasis with renal dysplasia in a dog.

Bartges *et al.* (1996) reported that measurements of uric acid concentration were most reproducible in canine urine samples stored at –20°C for one to two week when samples were diluted with 1:20 deionised water.

Weichselbaum *et al.* (1998) stated that size and shape of uroliths in conjunction with age, breed and sex facilitated pure urocystolith mineral type prediction.

Lekcharoensuk *et al.* (2000) stated that pet dogs had seven times greater risk for developing uroliths than dogs used for breeding, guarding, working, etc. Dogs with history of other illness or injury had less risk for developing urolith compared with dogs without history of illness or injury. Dogs given medication had less risk for developing uroliths compared with dogs not given any medication.

Stevenson and Markwell (2001) compared urine composition in Labrador Retriever and Miniature Schnauzers after feeding the same dog food and reported that the differences existed in urine volume, pH and calcium concentration. Higher calcium concentration contributed to the higher prevalence of calcium oxalate uroliths as observed in Miniature Schnauzers and recommended that difference between breeds should be considered when evaluating strategies for controlling calcium oxalate stone formation.

Lekcharoensuk *et al.* (2002b) reported that the canned foods with the highest amount of protein, fat, calcium, phosphorus, magnesium, sodium, potassium, chloride and moisture were associated with decreased risk of calcium oxalate urolith formation compared with diets with the lowest amounts.Canned diets with the highest amount of carbonate were associated with an increased risk of calcium oxalate urolith formation.

Raila *et al.* (2003) assessed the levels of retinal, retinyl esters, retinal binding protein (RBP) and Tamm-Horsefall (THP) in plasma and urine of dogs with the history of urolithiasis and found plasma retinal concentration higher in dogs with uroliths of struvite, calcium oxalate, urate and cystine .The results showed that Vitamin A deficiency should be excluded as a potential cause for canine urolithiasis.

Nandi *et al.* (2003) studied the prevalence of urolithiasis in relation to season and anatomical sites in dogs from September 2001 to August 2002 in West Bengal and found that prevalence of urolithiasis was 1.21 per cent .The prevalence was higher during the winter season followed by summer and least during rainy season.

Amarpal *et al.* (2004) in a review of five years reported that maximum incidence of urolithiasis was in caprine (49.83 per cent), followed by bovine (32.87 per cent), canine (14.53 per cent), equine (1.38 per cent), ovine (1.04 per cent) and feline (0.34 per cent). The occurrence of canine urolithiasis was minimum in January and February.

HISTOPATHOLOGY

Sastry and Rao (2001) reported leucocytic infiltration of the mucosa and submucosa and congestion of the blood vessels in histopathology of urinary bladder in urolithiasis.

# REGIONAL ANATOMY OF URINARY SYSTEM

## Urinary Bladder

Urinary bladder is a musculomembraneous sac, which differs in shape, size and position according to the amount of its contents. When moderately full it is oval in shape. The functional boundary between the bladder and the urethra is represented by a sphincter. Emptying of the bladder is accomplished by contraction of the bladder musculature which is arranged in three layers. The muscle layers converge on the neck of the bladder in such a way that their contraction shortens and widens the neck, decreasing urethral resistance.

Urine is transported from the renal pelvis to the urinary bladder by peristalsis in the ureters. The ureters enter the urinary bladder at an oblique angle to form a functional valve called the uretero vesicular valve. Once the urine has entered the bladder its back flow into the ureters is prevented as the bladder fills.

When a certain expanded volume is reached the pressure rises sharply, creating an urge to void urine. Once micturition proceeds, complete emptying is ensured because of brain stem reflex activated by flow receptors in the urethra. As long as urine is flowing, bladder contraction continues until there is no further flow.

## Histology

The epithelial cell of the urinary bladder is of transitional epithelium. When the bladder is empty the cells appear to be piled on one another giving a stratified appearance. A transition occurs on filling so that the piled up appearance gives way to a thinner epithelial stratification.

**Urethra**

*Male Urethra*

In male, urethra is the continuation of the duct system that arises at the urinary bladder and opens to the outside. It has a dual function of transporting urine as well as semen. The urethra is divisible into three portions - prostatic, membraneous and cavernous. The prostatic portion is surrounded by prostate gland. The membraneous portion is the narrowest and shortest, measuring about one centimetre in length. The cavernous portion is long and extends through the penis, cavernosum urethrae and opens at the end of the glans penis. The structure of the mucus membrane varies in different portion. The prostatic urethra is lined by a transitional epithelium similar to that of the bladder. In the membraneous and cavernous portions the epithelium is stratified columnar or pseudostratified thereafter it changes to stratified squamous epithelium. The epithelium rests on a thin basement membrane, beneath which is a stroma of loose connective tissue rich in elastic fibres and containing in its deeper portion is the plexus of capillaries and the thin walled veins. Smooth muscle fibres both, longitudinal and circular are found in the prostatic and membraneous portions (Fig. 1).

*Female Urethra*

The female urethra runs caudally on the pelvic floor below the reproductive tract. It passes obliquely through the vaginal wall to open ventrally at the junction of vagina and vestibule.

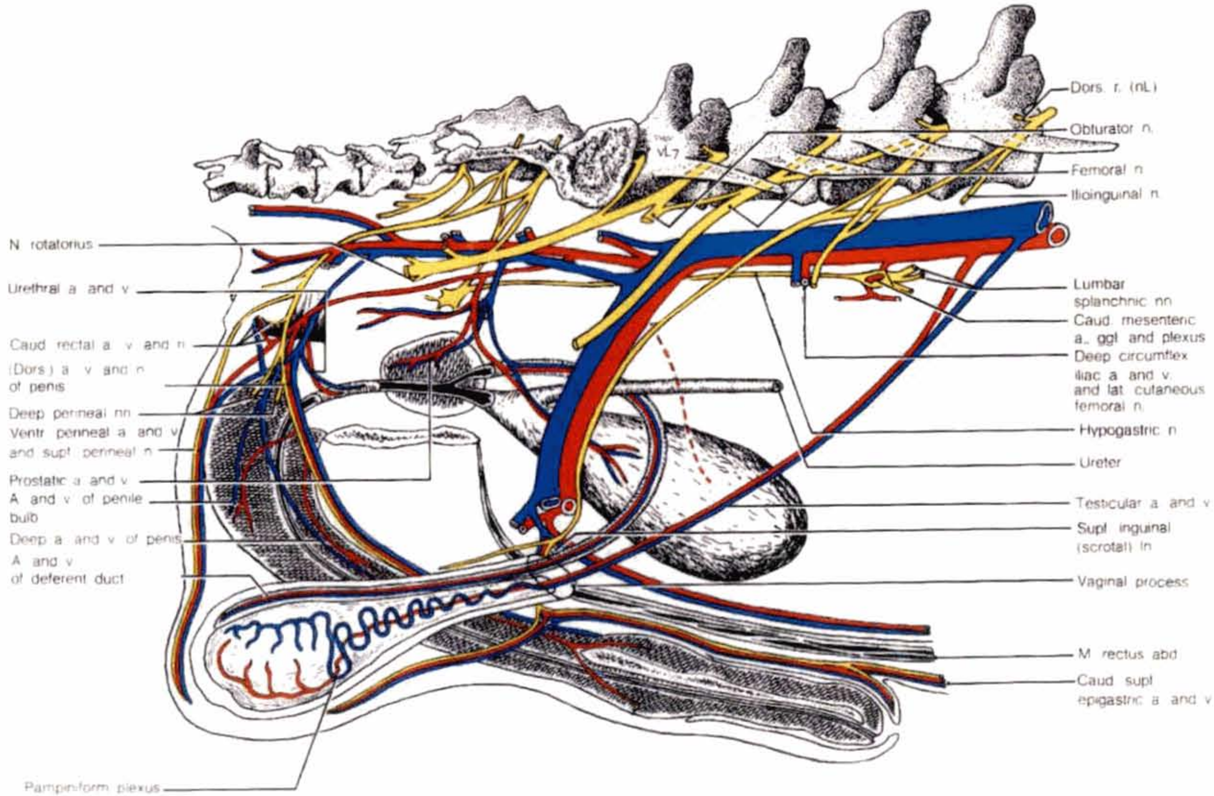
The urethral submucosa contain mainly veins that constitute a form of erectile tissue that may contribute to continence by assisting mucosal apposition. The structure of the urethra continues with that of the bladder (Fig.2).

*Blood and Nerve Supply to Urinary Bladder and Urethra*

The bladder receives its blood supply from the cranial and caudal vesical arteries which are branches of the umbilical and urogenital arteries. Sympathetic innervation is from the hypogastric nerves while parasympathetic innervations is via the pelvic nerve. The pudental nerve supplies somatic innervations to the external bladder sphincter and urethra (Dyce *et al.*, 1996).

Fig.1 Diagrammatic representation of lower urinary system – Male dog (lateral view)

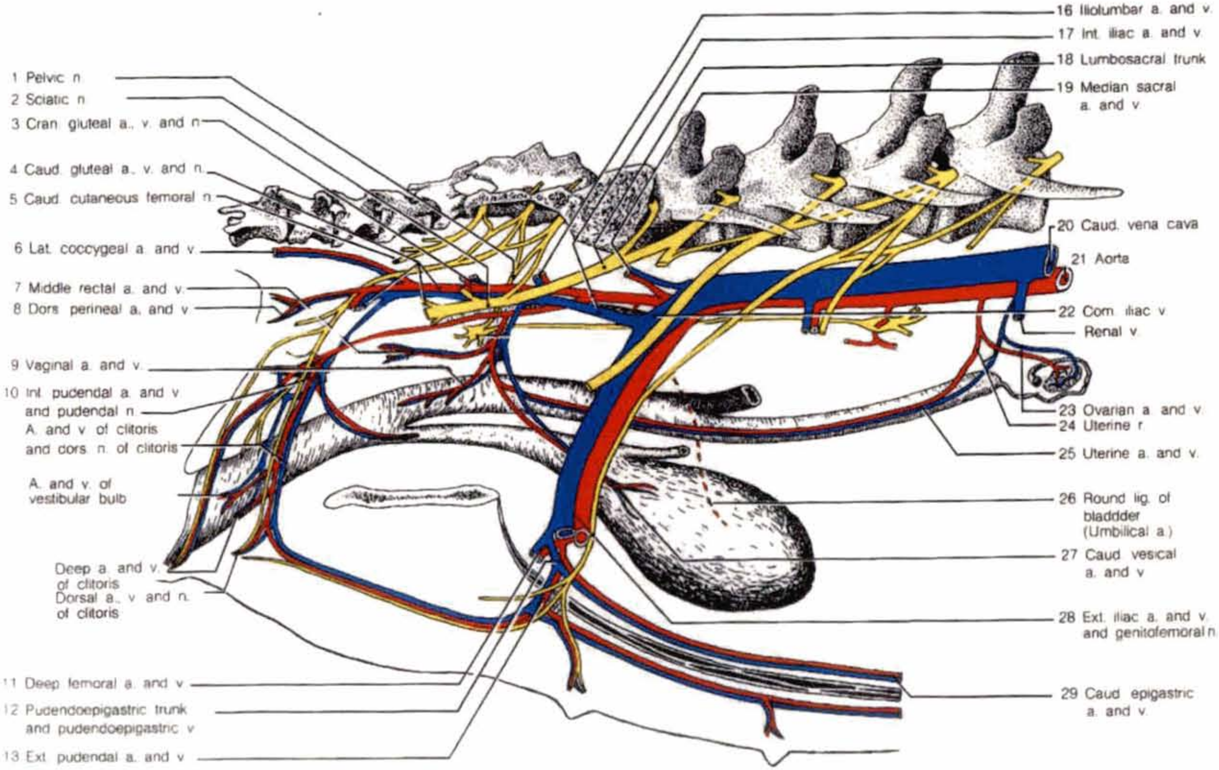
Fig. 1



Dors. r. (nL)
Obturator n.
Femoral n.
Ilioinguinal n.
N. rotatorius
Urethral a. and v.
Caud. rectal a., v. and n.
(Dors.) a., v. and n. of penis
Deep perineal nn.
Ventr. perineal a. and v. and supf. perineal n.
Prostatic a. and v.
A. and v. of penile bulb
Deep a. and v. of penis
A. and v. of deferent duct
Lumbar splanchnic nn.
Caud. mesenteric a., ggl. and plexus
Deep circumflex iliac a. and v. and lat. cutaneous femoral n.
Hypogastric n.
Ureter
Testicular a. and v.
Supf. inguinal (scrotal) ln.
Vaginal process
M. rectus abd.
Caud. supf. epigastric a. and v.
Pampiniform plexus

**Fig.2 Diagrammatic representation of lower urinary system – Female dog (lateral view)**

Fig. 2


1 Pelvic n.
2 Sciatic n.
3 Cran. gluteal a., v. and n.
4 Caud. gluteal a., v. and n.
5 Caud. cutaneous femoral n.
6 Lat. coccygeal a. and v.
7 Middle rectal a. and v.
8 Dors. perineal a. and v.
9 Vaginal a. and v.
10 Int. pudendal a. and v. and pudendal n.
A. and v. of clitoris and dors. n. of clitoris
A. and v. of vestibular bulb
Deep a. and v. of clitoris
Dorsal a., v. and n. of clitoris
11 Deep femoral a. and v.
12 Pudendoepigastric trunk and pudendoepigastric v.
13 Ext. pudendal a. and v.
16 Iliolumbar a. and v.
17 Int. iliac a. and v.
18 Lumbosacral trunk
19 Median sacral a. and v.
20 Caud. vena cava
21 Aorta
22 Com. iliac v.
Renal v.
23 Ovarian a. and v.
24 Uterine r.
25 Uterine a. and v.
26 Round lig. of bladdder (Umbilical a.)
27 Caud. vesical a. and v.
28 Ext. iliac a. and v. and genitofemoral n.
29 Caud. epigastric a. and v.

# *Materials and Methods*

# MATERIALS AND METHODS

## SELECTION OF ANIMALS

The dogs presented at Veterinary Hospital, Mannuthy and Kokkalai with difficulty in urination were subjected to detailed clinical examination. The dogs which showed difficulty in catheterization of urethra were subjected to survey radiography. Of these, ten cases which were diagnosed to have calculi either in the urinary bladder or urethra or in both were utilized for the study. The animals were serially numbered as D1, D2, D3, D4, D5, D6, D7, D8, D9 and D10.

The dogs with large cystic calculi and calculi at the bladder neck were subjected to cystotomy and those having urethral and or small cystic calculi were subjected to urethrotomy. Of the ten animals, two dogs (D2 and D5) showed recurrence after five and ten months respectively. The animal D2 was subjected to urethrotomy and animal D5 urethrotomy and cystotomy again.

## EVALUATION OF ANIMAL

### Signalment

Breed, sex, age of the animals and whether castrated or uncastrated were recorded.

History of previous illness, treatment given if any, feeding and voiding habits and management aspects of all the animals were recorded.

## CLINICAL SIGNS

All the animals were observed for the clinical symptoms exhibited.

### Physiological Parameters

Respiratory rate (per min), rectal temperature (°C), pulse rate (per min), and colour of the conjuctival mucous membrane were recorded.

**Physical Observation**

All the animals were physically examined. The abdomen and urinary bladder were palpated and the changes were recorded.

**Catheterization**

All the animals were catheterized to locate the site of obstruction. Sterile infant feeding tubes of sizes from 5 FG to 10 FG were used for catheterization according to the requirement in each animal. The catheters lubricated with xylocaine gel was introduced through the urethral orifice to locate the site of obstruction and to catheterize the urinary bladder.

RADIOGRAPHIC EVALUATION

**Survey Radiography (Fig.3 and 4)**

All the animals were subjected to survey radiography. Lateral radiograph including abdomen, pelvis, perineal region and the course of urethra was taken to locate the calculi and to identify the status of urinary bladder and urethra.

ULTRASONOGRAPHIC EVALUATION

Ultrasonography of the urinary bladder was carried out in two animals (D3 and D8) (Fig.5) and the findings were recorded.

OPERATIVE PROCEDURE

Among the 14 operations performed in 10 dogs, urethrotomy alone was done in nine, urethrotomy and cystotomy in two and cystotomy alone in one animal.

Urethrotomy behind the level of os penis (prescrotal) was carried out in seven animals (D2, D4, D5, D6, D7, D9 and D10) and post scrotal urethrotomy in two animals (D1 and D8). In D3 cystotomy was performed to remove cystic calculi and the calculi lodged at the bladder neck. In one animal (D8) both cystotomy and post scrotal urethrotomy was required to remove the calculi. In animals with recurrence of calculi urethrotomy was performed in one animal (D2) and urethrotomy and cystotomy in animal D5.

**Preparation of the Patient**

For the urethrotomy in male dogs the prepucial region were prepared by shaving and scrubbing the site with chlorhexidine-cetrimide[1] antiseptic lotion, washed, mopped dry and applied Tr. iodine (Fig.6). In post scrotal urethrotomy the region behind the scrotum extending to the ischial arch was prepared in the same manner.

For cystotomy in both male and female dogs the caudal mid ventral abdomen was shaved, scrubbed with chlorheximide-cetrimide antiseptic lotion, washed, mopped, and applied Tr. iodine.

**Anaesthesia**

All the animals were administered atropine sulphate[2] as a premedicant at a dose rate of 0.04 mg per kg body weight intramuscularly. After 15 minutes, xylazine hydrochloride[3] at the dose rate of 1mg /kg body weight was administered intramuscularly to induce sedation. In all the animals, local infiltration anaesthesia was carried out at the proposed site of incision by infiltrating two ml of 2% lignocaine hydrochloride[4] solution for urethrotomy and five ml for cystotomy.

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1 Zelon – Chlorhexidine gluconate solution 0.3% w/v, cetrimide 0.6% w/v. Unichem Laboratories Ltd., Mumbai.
2 Atropine Sulphate 0.6 mg/ml, Hindustan Pharmaceuticals, Barauni
3 Xylaxin 20 mg/ml, Indian Immunologicals Ltd., Guntur
4 Xylocaine 2% Lignocaine Injection I.P., Astra IDL, Bangalore

**Surgical technique**

*Urethrotomy*

The animals were controlled on dorsal recumbency. The surgical site was draped and fixed with towel forceps. A sterile probe lubricated with xylocaine gel was inserted through the external urethral orifice till the level of obstruction while holding the penis firmly between the thumb and index finger (Fig.7). A two centimeter incision was made precisely in the midline on the skin. The subcutaneous tissue was incised and the paired retractor penis muscles on the ventral surface of the urethra was separated (Fig.8). The incision was continued through the white tunica albugenia and the urethral wall to reach the lumen (Fig.9). On incising the urethra, the scalpel blade grated on the impacting calculi wherever the calculi was lodged at the site. In most of the cases calculi were lodged in the urethra; in the groove of the os penis. The calculi lodged in the groove and posterior to the level of os penis were removed by prescrotal urethrotomy. The calculi at the site of incision was expelled while incising the urethra along with urine spurts.

The remaining calculi lodged near the incision were removed one by one with the help of artery forceps (Fig.10). The calculi lodged within the groove of os penis were gently dislodged by passing a 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 incisions, were removed by means of a mosquito forceps inserted through the urethral incision. Occasional flushing of the urethra with sterile normal saline was carried out to dislodge the calculi.

Calculi lodged posterior to the os penis were removed by inserting forceps. Gentle compression of the bladder over the abdominal wall facilitated expulsion of the calculi along with the urine. 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. In all the animals, all the calculi lodged in the course of urethra were removed completely. The patency of the urethra was confirmed by passing a sterile catheter (Fig.11). Urine samples were collected in sterile vial for cultural examination and for analysis. Bleeding from the urethra was noticed in few cases and it was controlled by instilling haemocoagulase solution[1].

After removal of calculi the bladder was flushed thoroughly with sterile normal saline infused through the catheter and the bladder was compressed gently after the removal of catheter to favour expulsion of the urine with the epithelial cast or calculi present, if any.

The skin wound was reduced in size by putting simple interrupted sutures on either side of the wound with braided silk 1/0 (Fig.12). The urethral incision was not sutured. The catheter was introduced into the bladder through the normal urethral orifice and was fixed to the prepucial skin by applying simple interrupted suture (Fig.13). After the operations survey radiograph was taken with catheter in situ to check the presence of calculi and patency (Fig.14) wherever necessary.

*Cystotomy*

In males, the skin incision was put lateral to the prepucial sheath and in females, laparotomy incision was made directly on the midline at its posterior one-third for a length of six centimetre. Incised the skin, fascia and linea alba to expose the urinary bladder (Fig.15). Exteriorized the urinary bladder and put a nick incision on the dorsal aspect on less vascular area through which the catheter was introduced and evacuated the urine through the catheter (Fig.16). The nick incision made was enlarged by incising on either side (Fig.17). The calculi were visible through the incision (Fig.18) and were removed by forceps. After the removal of the calculi, the bladder was thoroughly explored with finger to detect and remove any remaining calculi. The calculi lodged at the bladder neck in one female dog (D3) was removed by a forceps. Flushing of the bladder was carried out with sterile normal solution and a catheter was introduced through the bladder

1 Botroclot – Sterile haemocoagulase solution, Topical Solution0.2 cu/ml, Juggat Pharma, Bangalore

(Fig.19) into the urethra and the other end was taken out through external urethral orifice and fixed in position. The cystotomy wound was closed by double layer inversion sutures; Cushing followed by continuous Lembert using chromic catgut No. 2/0 (Fig. 20). The peritoneum along with linea alba was sutured using braided silk No. 1/0 (Fig.21) and the skin wound was closed by vertical mattress suture using fine monofilament nylon (Fig.22).

***Observation during Surgery***

The difficulty encountered, if any, during surgery for the removal of calculi or for passing and fixing of catheter after operation were recorded. From all the animals urine samples were collected during surgery in two separate sterile vials. The pH, colour and consistency of the urine samples were immediately recorded and urine samples collected in sterile vials were subjected for cultural examination and sensitivity test . The calculi removed were observed for its size, shape and as far as possible, the number and the observations were recorded. Calculi retrieved from all the animals were subjected to chemical analysis for composition and one calculus was subjected to electron microscopic study.

POST OPERATIVE MANAGEMENT

The exposed end of the catheter taken out through the urethral orifice was sutured to the prepucial skin so as to keep *in situ.* The skin wound was painted with Tr. benzoin and a thick pad of sterile cotton was applied over the wound and fixed with adhesive tape. Wherever removal of the catheter by the animal was noticed no attempt was made to reintroduce the catheter into the urethra.

All the animals were administered Lactated Ringer's[1] solution at the dose rate of 10 ml/kg body weight. Ampicillin-cloxacillin[2] injection was administered in all animals at the dose rate of 10mg/kg body weight for three consecutive days

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1 Ringer lactate 540 ml. Albert David Ltd., Calcutta, W. Bengal
2. Megapen Kid Tab (Ampicillin 125 mg, closcacillin 125 mg) Aristo Ltd., Mumbai, Maharashtra.

along with frusimide[1] @ 2-4 mg/kg twice daily as diuretics. Thereafter specific antibiotics were administered based on the results of culture and sensitivity test of the urine collected. Appropriate medication for alkalisation of the urine was recommended. For alkalisation disodium hydrogen citrate[2] one teaspoon twice daily for two weeks and cystone[3], one tablet twice daily were administered for one month. 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.

After the surgery retension of the catheter (catheter tolerance), healing of surgical wound, complications noticed if any, were recorded. Bleeding was controlled by the injection of ethamsylate[4] injection.

Dressing of urethrotomy and laparotomy wound was done by framycetin[5] ointment.

Observations were made on 7th and 30th post operative day. The animals were re-examined at monthly intervals for a period for three months in order to ascertain the clinical status of the animal and for recurrence of the calculi, if any.

HAEMATOLOGICAL EVALUATION

Blood smear from all the animals were prepared for differential leucocytic count. Blood samples were collected in citrated vials from all the animals before surgery and on 7th and 30th post operative day for haematological examination. Haemoglobin concentration (Hb), Volume of Packed Red Cells (VPRC), Total erythrocyte count (TEC), Total leucocyte count (TLC) and Erythrocyte sedimentation rate (ESR) were estimated as recommended by Benjamin (2001).

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1 Lasix Tab 40 mg Hoechst Marion Roussel Ltd. Mumbai, Maharashtra.
2 Citralka – 1.5 mg/5 ml Parke Davis Ltd. Mumbai, Maharashtra.
3 Cystone – Herbal product. Himalaya Ltd., Makali, Bangalore
4. Ethamsylate – Dicynene 250 mg/2 ml, Dr. Reddy's Laboratories Ltd., Hyderabad
5. Soframycin skin cream. Framycetin Roussel Mumbai, Maharashtra

BIOCHEMICAL ANALYSIS

Blood samples collected before surgery and on 7$^{th}$ and 30$^{th}$ post operative day were subjected for serum biochemical evaluation. Blood urea nitrogen (BUN), phosphorus (P) and creatinine were estimated by using standard Agappe Diagnostic kit[1]. Sodium (Na), calcium (Ca) and potassium (K) were analysed by flame photometry.

URINALYSIS

Urine samples were collected from all the animals during surgery in sterile vials for the analysis of the following.

pH

The pH was measured by Hydrion pH indicator paper immediately after collection of urine (Benjamin, 2001).

**Cultural Examination of Urine**

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

**Colour and Consistency**

The urine samples collected in transparent vials were examined for colour and consistency and were recorded accordingly.

**Microscopic Examination**

Microscopic examination of the sediments of the urine samples were examined for the presence of crystals, if any.

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[1] Agappe Diagnostics, Thana, Maharashtra

*Preparation of the Sediment*

The urine samples were mixed well and poured into conical tipped tube, and centrifuged for three minutes at low rate of speed. The supernatant was discarded. Sediment was transferred to a slide and examined under microscope (low and high power) and later it was stained with Leishman Stain for the identification of crystal (Benjamin, 2001).

The shapes of commonly occurring crystals were studied and recorded.

CALCULI ANALYSIS

The type, colour, shape and size of calculi removed were recorded. The calculi were stored for quantitative analysis. Storage was effected by sun drying and wrapping in the paper.

The percentage of calcium, magnesium and phosphorus was analysed by Atomic Absorption Spectrometer and recorded.

HISTOPATHOLOGY

In dogs undergone cystotomy, biopsy of the urinary bladder was done for histopathological examination. The specimen collected from the bladder edges were processed, longitudinal sections at 5 microns thickness were prepared and stained with hematoxylin and eosin stain (Bancroft and Cook, 1984).

ELECTRON MICROSCOPIC STUDY

Electron microscopic study of a calculus was conducted to evaluate its structure.

STATISTICAL ANALYSIS

The data obtained were analysed and compared using students 't' test (Snedecor and Cochran, 1994).

Fig.3 Skiagram showing presence of calculi in the bladder and bladder neck in animal D3

Fig.4 Skiagram showing presence of urethral calculi lodging in the groove of os penis in animal D7

Fig. 3

Fig. 4

**Fig.5** **Sonography showing hyperechoic area with shadowing in the urinary bladder of dog indicating cystic calculi in animal D3**

**Fig.6** **Prepared site for prescrotal urethrotomy in animal D10**

Fig. 5

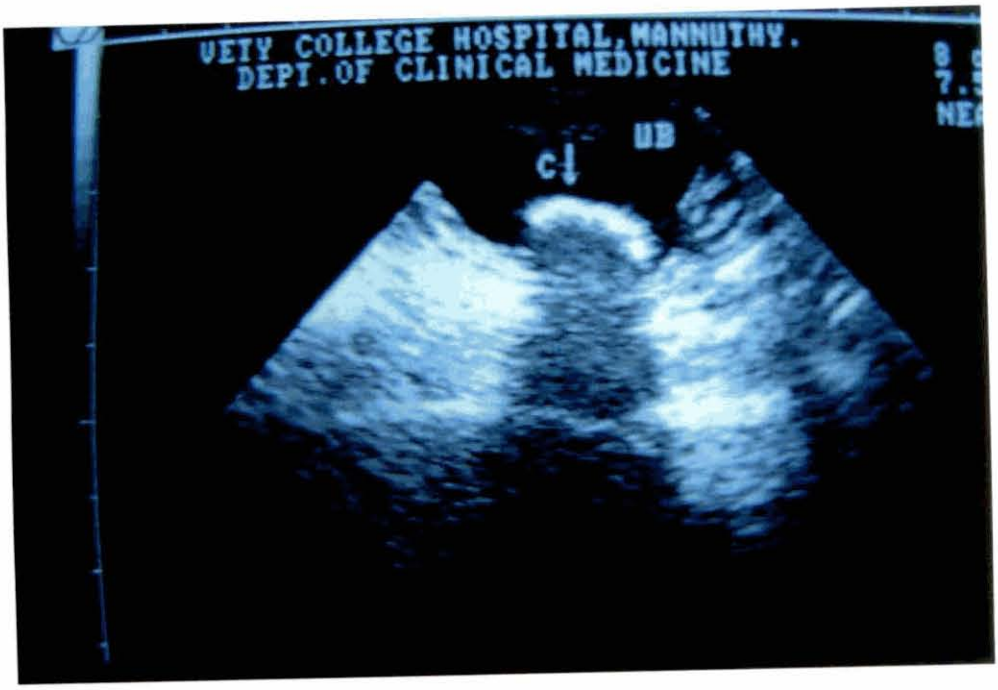
VETY COLLEGE HOSPITAL,MANNUTHY.
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Fig. 6

**Fig.7** **Metal probe inserted through the external urethral orifice to locate the calculi in animal D4**

**Fig.8** **Urethrotomy operation showing isolation of retractor penis muscle in animal D10**

Fig.7

Fig. 8

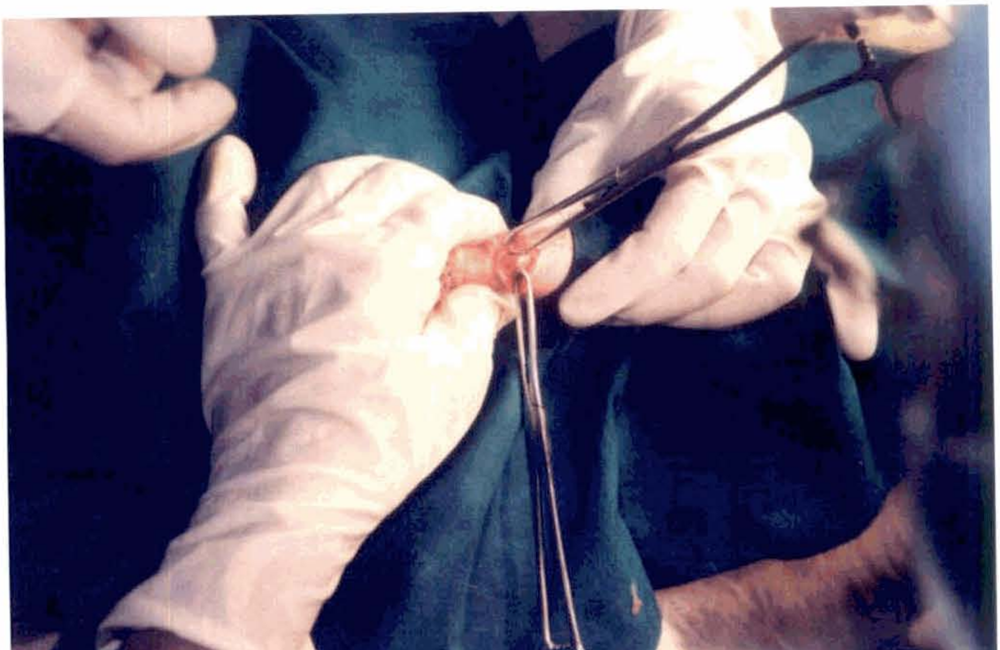


Fig.9 Urethrotomy incision extended to the urethral lumen in animal D10

Fig.10 Removal of calculi with the help of artery forceps in animal D10

Fig. 9

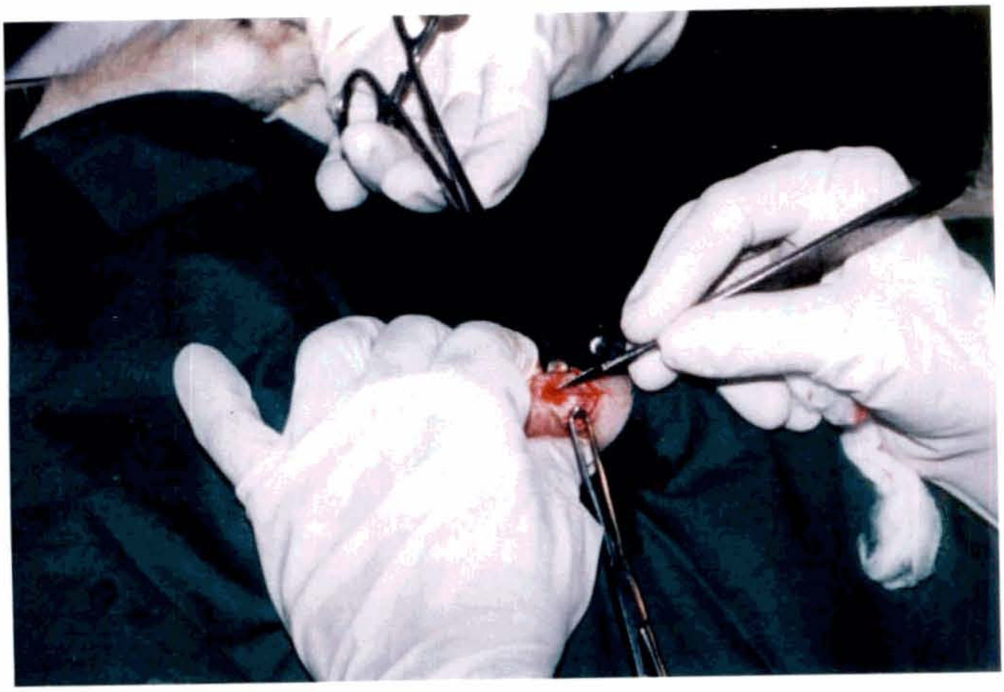


Fig. 10

**Fig.11** **Catheter introduced to check the patency of the urethra in animal D10**

**Fig.12** **Incision wound reduced in size by putting simple interrupted suture in animal D10**

Fig.11

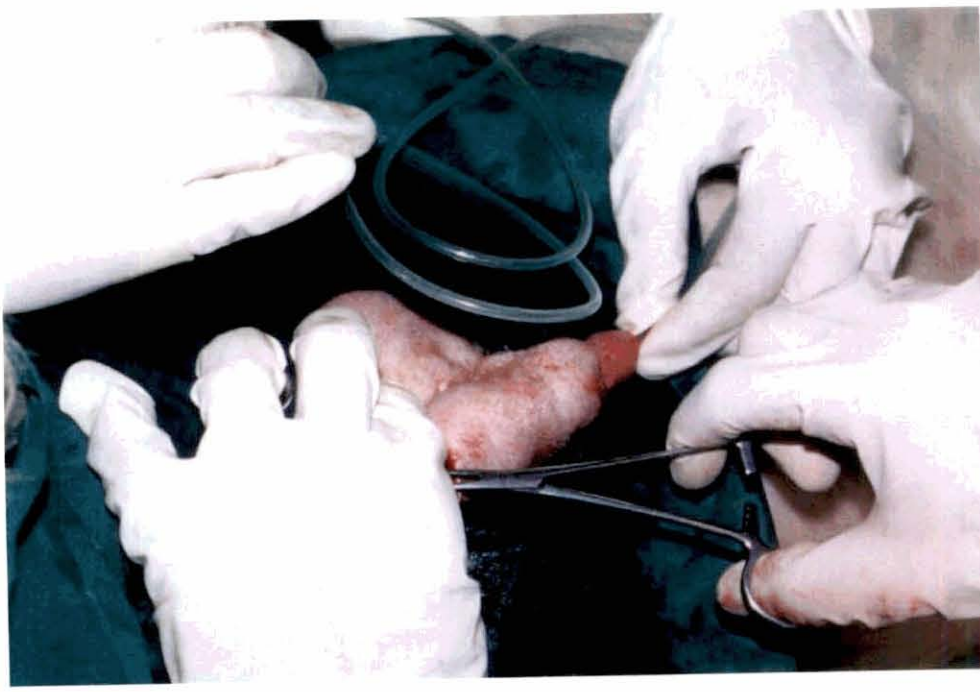


Fig. 12

**Fig.13** Prescrotal urethrotomy site after completion of operation and the catheter fixed in position in animal D10

**Fig.14** Skiagram showing the position of flexible catheter inserted to check the patency and presence of calculi after urethrotomy

Fig. 13

Fig. 14

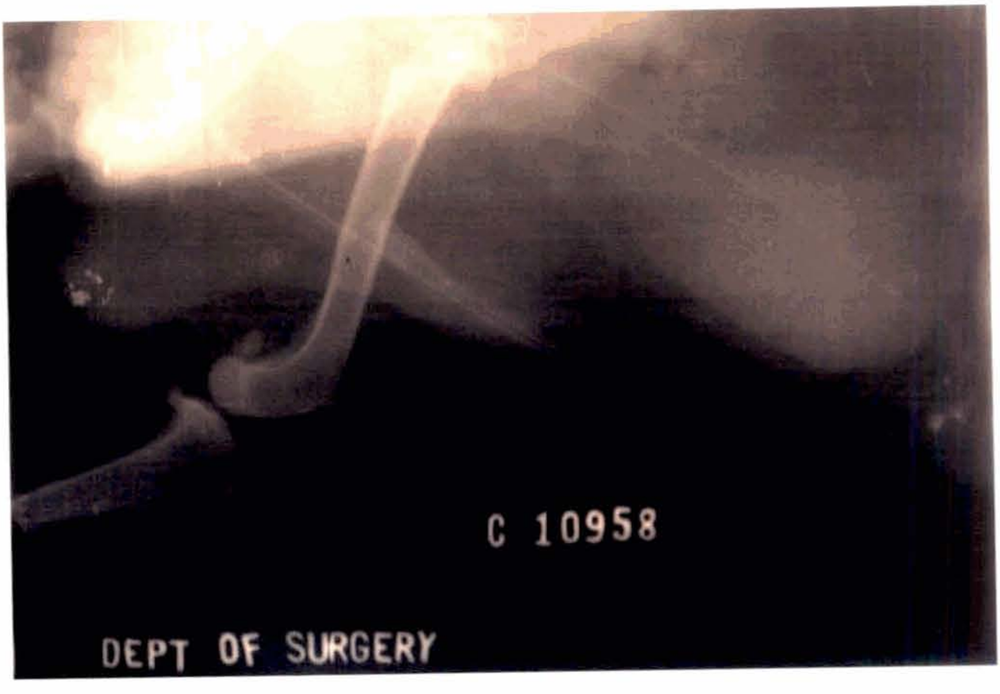


**Fig.15** **Cystotomy site after laparotomy in animal D5**

**Fig.16** **Exteriorized urinary bladder with catheter inserted to evacuate the urine in animal D5**

Fig. 15

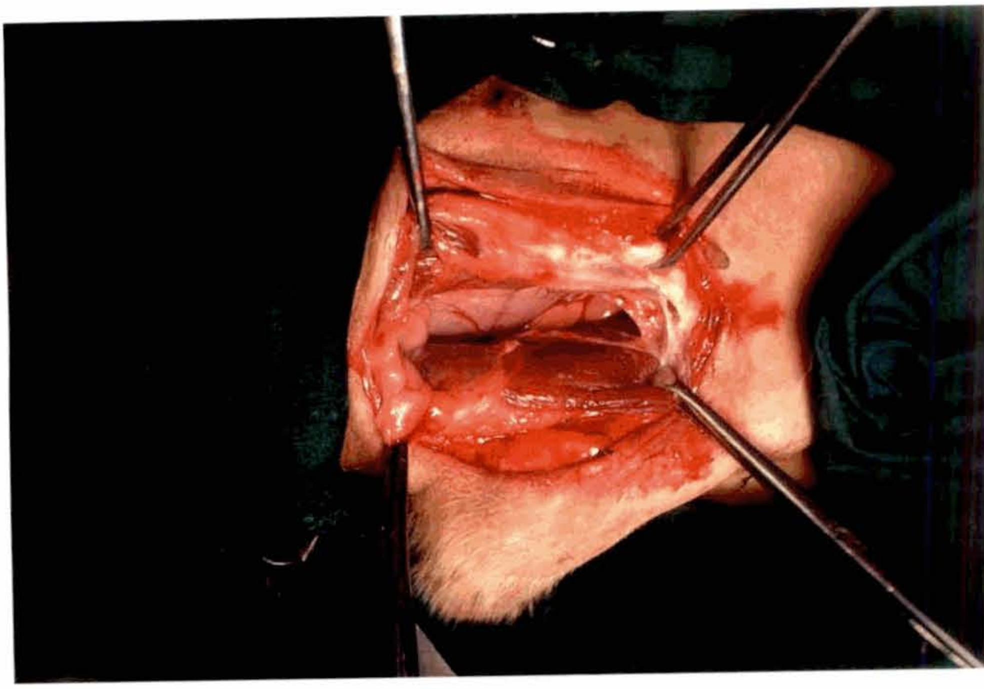


Fig. 16

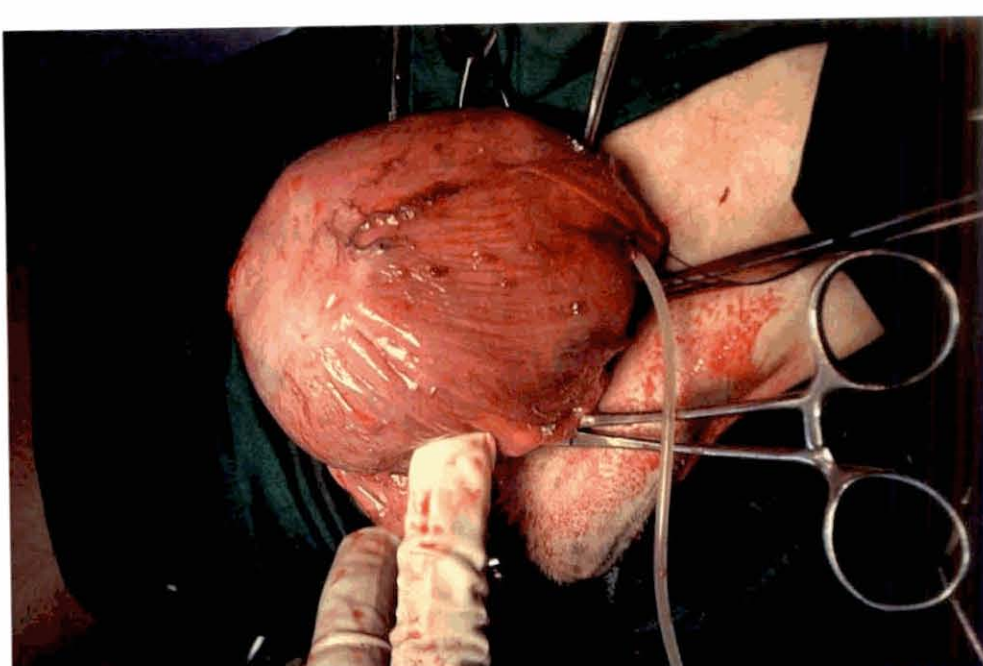


**Fig.17** Incision on the urinary bladder at the dorsal aspect on the less vascular area in animal D5

**Fig.18** Cystotomy wound through which the calculi is visible in animal D5

Fig. 17

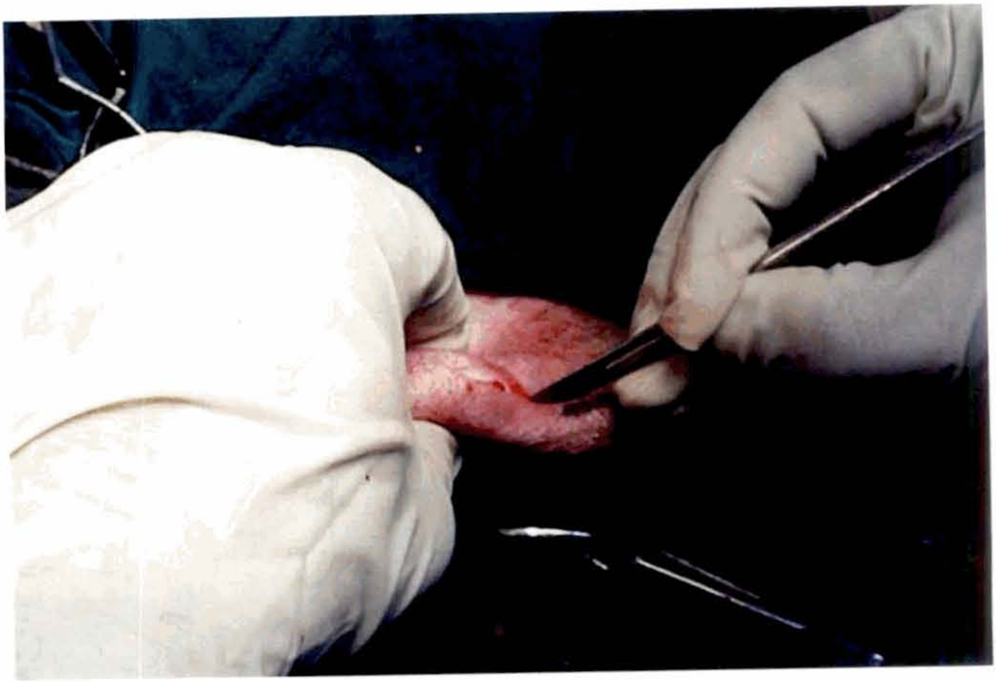


Fig. 18

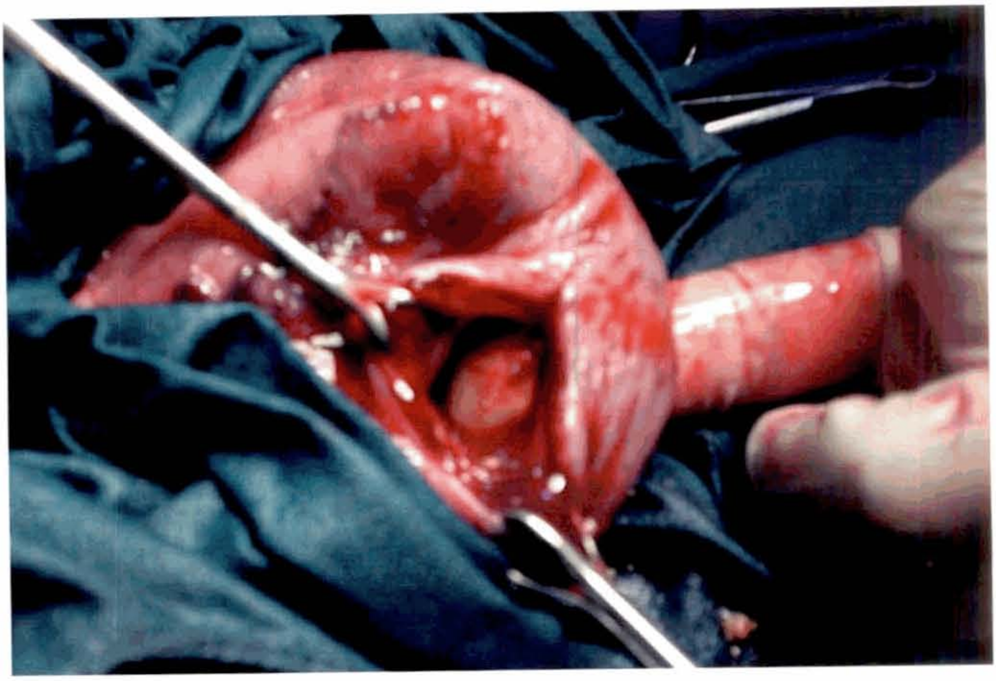


**Fig.19** **Cystotomy – Introduction of the catheter through the bladder in animal D5**

**Fig.20** **Closure of the urinary bladder by double inversion suture in animal D5**

Fig. 19

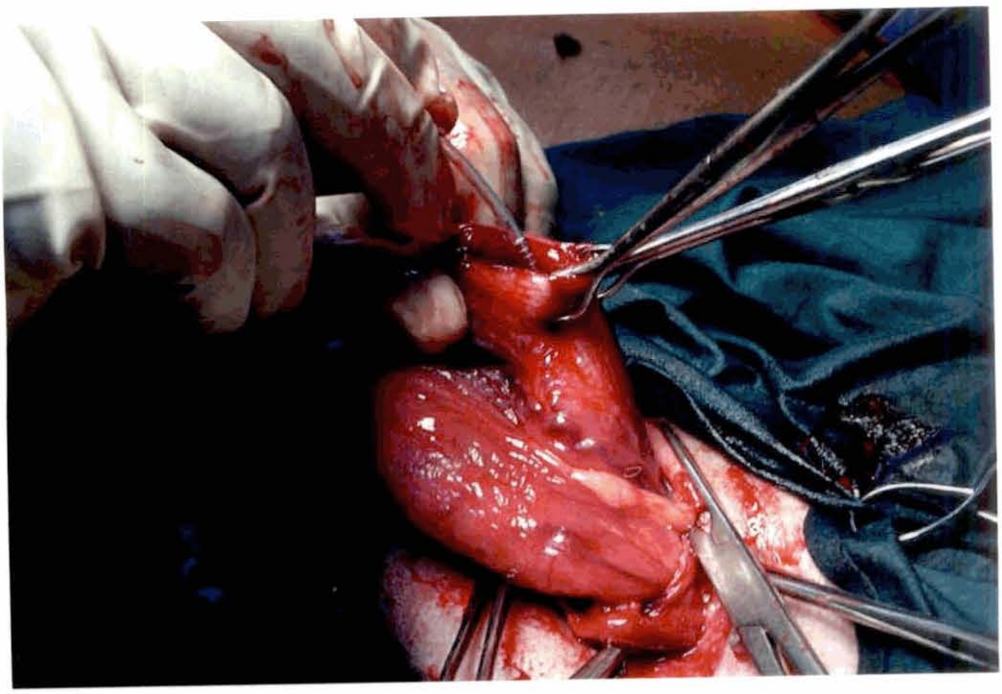


Fig. 20

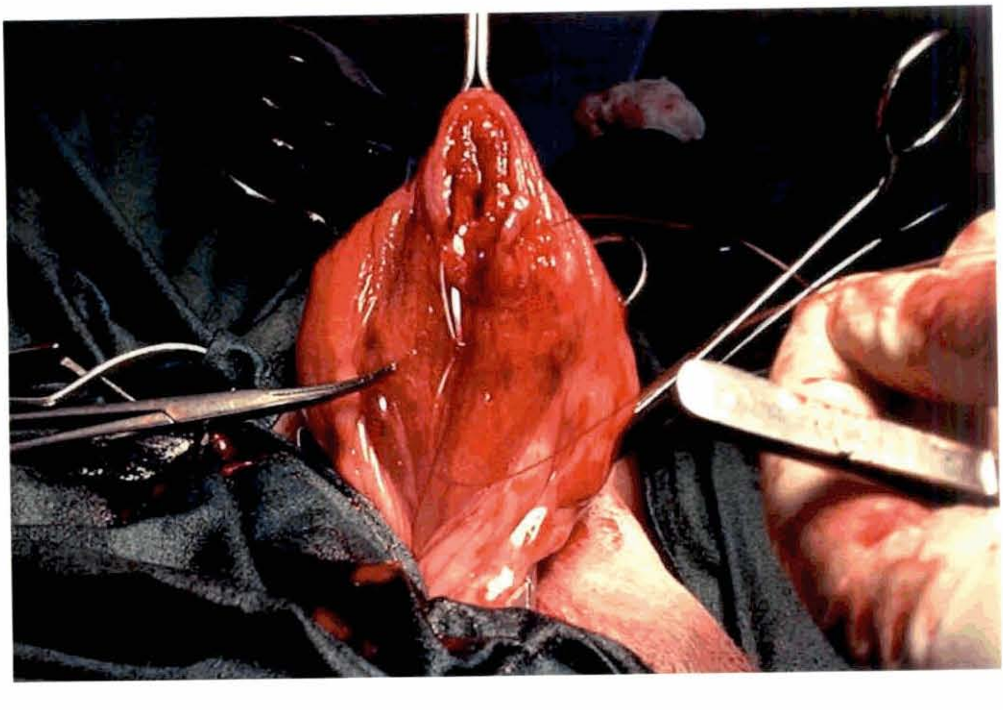


**Fig.21 Closure of the abdominal wound and peritoneum in animal D5**

**Fig.22 Suturing of the skin wound in animal D5**

Fig. 21

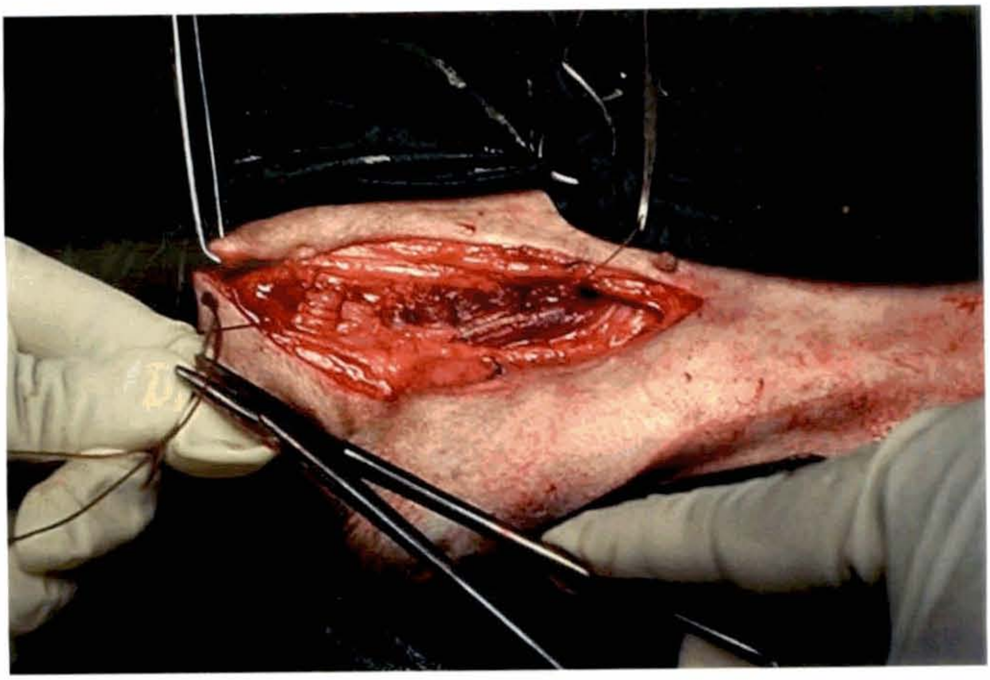
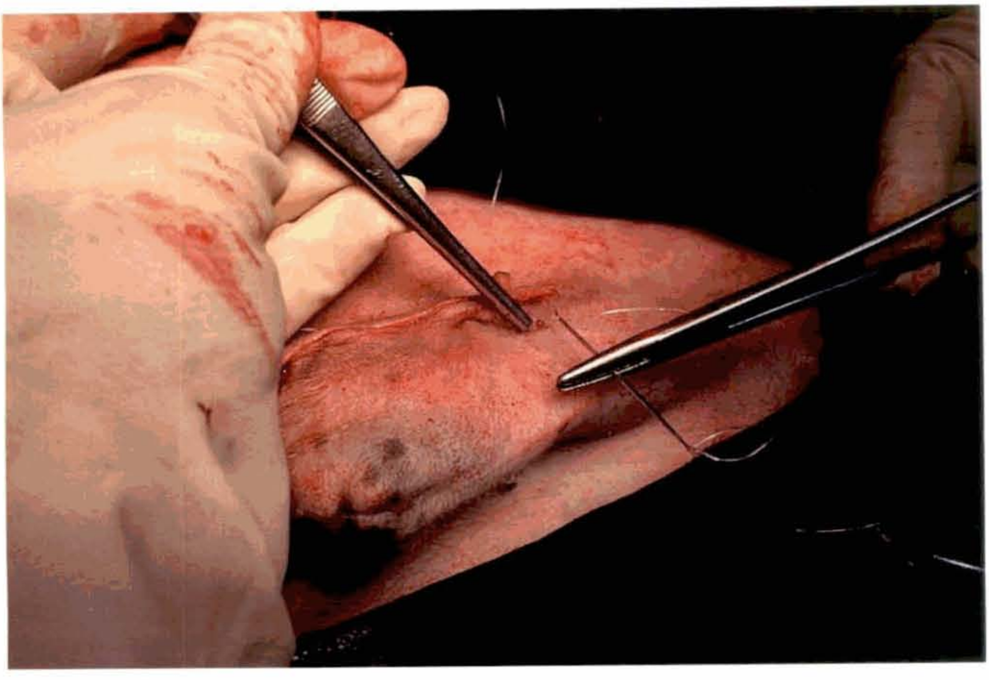


Fig. 22



# *Results*

# RESULTS

The present study was carried out in ten dogs presented at Veterinary hospitals, Mannuthy and Kokkalai which were diagnosed to have urolithiasis.

Of the ten animals studied, six had urethral calculi, three animals had both urethral and cystic calculi and one female had cystic calculi at the bladder neck and in the bladder. Among these urethrotomy was performed in nine animals, urethrtomy and cystotomy in one each and cystotomy alone in one animal.

Recurrence was noticed in two animals (D2 and D5) which had urethral and cystic calculi initially. On recurrence calculi were present in the urethra and urinary bladder in both the animals. Urethrotomy was performed in animal D2 and urethrotomy and cystotomy in animal D5 to remove the calculi.

INCIDENCE (Table 1)

**Age**

The average age incidence of urolithiasis was 6.3 years. Average age in males was 6.1 years. There was only one female of age eight years in the study.

**Breed**

Out of the ten dogs three were German Shepherd Dog, two each were Pomeranian and Labrador and one each Boxer, Dachshund and Rottweiler. Relatively, incidence were more in German Shepherd Dog followed by Pomeranian and Labrador. The incidence in Boxer, Dachshund and Rottweiler was comparatively less.

**Sex**

There were nine males and one female in the study and all the animals were intact.

HISTORY

Among the animals studied two had previous history of partial or complete urinary obstruction (D2 and D9). Both of them were operated for urethrotomy one and two years back respectively.

**Feeding Habit**

All the animals were fed with more non vegetarian diet regularly composed of meat, fish and egg.

**Duration of Illness**

The duration of illness in the present study varied from a period of one week to three weeks.

CLINICAL SIGNS (Table 2)

Out of ten animals one animal (D8) was dull and weak in appearance and all others were active.

Food and water intake was reported to be reduced in eight dogs (D1, D2, D3, D4, D5, D6, D8 and D10).

Two animals (D3 and D8) showed emesis.

Difficulty in urination was reported in all the animals. Haematuria was reported in five animals (D3, D5, D6, D7 and D10). Abdominal distension was noticed in nine animals. Palpation of the abdomen revealed distended urinary bladder in all animals except in one (D8) where bladder could not be clearly palpated and fluid thrill was observed on abdominal palpation indicating rupture of urinary bladder.

PHYSIOLOGICAL PARAMETERS (Table 3)

The mean rectal temperature (°C) before surgery was 39.27 ± 0.08. It was 39.20 ± 0.08 and 39.07 ± 0.09 respectively on 7$^{th}$ and 30$^{th}$ day of operation.

The mean pulse rate (per minute) before surgery was 119.67 ± 4.42. It was 113.22 ± 5.14 and 115.00 ± 3.92 respectively on 7$^{th}$ and 30$^{th}$ day of operation.

The mean respiratory rate (per minute) before surgery was 50.22 ± 7.45. It was 50.33 ± 6.05 and 51.00 ± 6.38 respectively on 7$^{th}$ and 30$^{th}$ day of operation.

The variations observed in physiological parameters were not significant.

RADIOGRAPHIC EVALUATION

Lateral radiograph of the abdomen revealed distension of urinary bladder in nine animals. In one animal (D8) shadow of urinary bladder was not clear, suggestive of rupture of urinary bladder.

**Site of Obstruction** (Table 4)

In 12 cases, including two recurrence, the site of obstruction by the urinary calculi were at the ischial arch of the urethra in two dogs D1 and D8 (16.6%), groove of the os penis in six dogs D2, D4, D5, D6, D7 and D9 (50%), behind the os penis in two dogs D2 and D10 (16.3%) and at the neck of urinary bladder in one animal D3 (8.3%). Of these animals calculi were also seen in the urinary bladder in six animals, D2, D3, D5, D8, D9 and D2 on recurrence (50%). In D2 on recurrence, the calculi was again seen in the urinary bladder and behind the os penis.

## ULTRASONOGRAPHIC EVALUATION

Ultrasonographic evaluation of the urinary bladder in two animals (D3 and D8) revealed hyperechoic shadowing in the urinary bladder indicating cystic calculi.

## SURGICAL APPROACH

### Catheterization

For evaluating the patency of the urethra catheterization was carried out by using 6 FG to 10 FG infant feeding tube lubricated with lignocaine gel according to the size of the animals.

Catheter could not be passed beyond the level of ischial arch in animal D1 and D8. Catheter could be passed only up to the level of os penis in animal D2, D9 and D10.

Catheterisation of urethra was feasible only upto the middle of os penis in six animals (D2, D4, D5, D6, D7 and D9).

In animal D3 catheter could be passed only upto the level of bladder neck.

After locating the site of obstruction urethrotomy and or cystotomy was carried out to relieve the obstruction. Of the 14 operations in 10 animals, nine urethrotomy, two urethrotomy and cystotomy each and one cystotomy was performed (Table 5).

### Anaesthesia

The anaesthesia using atropine sulphate as a preanaesthetic, xylazine for induction of sedation and local infiltration anaesthesia at the site of surgery using 2% xylocaine was found to be satisfactory in all the animals.

Urethrotomy behind the level of os penis (prescrotal) was carried out in seven animals (D2, D4, D5, D6, D7, D9 and D10) and post scrotal urethrotomy in two animals (D1 and D8). In animal D3 cystotomy was performed to remove cystic calculi and the calculi lodged at the bladder neck. In one animal (D8) both cystotomy and post scrotal urethrotomy was required to remove the calculi. In animals with recurrence urethrotomy was performed in one animal (D2) urethrotomy and cystotomy in animal D5.

**Observation during Surgery**

On incising the urethra, the calculi lodged at the site of incision could be easily removed by forceps. In few cases calculi expelled out along with urine spurts. Those calculi which were lodged in the groove of os penis could be removed by introducing the metal probe through the urethral orifice and dislodging it. Occasional flushing of penile portion of urethra with sterile normal saline facilitated dislodgement of calculi remaining further.

In obstruction posterior to the level of os penis, the calculi was removed after urethrotomy just behind the level of os penis. The urethral opening was kept widened by introducing a forceps and the bladder was gently compressed towards the urethral orifice to evacuate the urine and the small calculi present in the bladder. In most of the cases it helped to dislodge the calculi and the calculi were flushed out along with the urine. Patency of the urethra was established by catheter introduced from the incision site towards the bladder.

In two animals (D1 and D8) post scrotal urethrotomy was performed and the calculi could be removed without much difficulty. Compression of the bladder showed free flow of urine through the surgical site.

Urine sample was collected in sterile vial from all the animals immediately after the removal of calculi by a sterile catheter inserted into the bladder before flushing the bladder. Catheterization of the bladder through the urethral orifice was performed with ease.

In all other animals except one animal (D3) prescrotal urethrotomy was performed to remove the urethral calculi. Removal of calculi was easy in all animals except in animal D2 where the calculi deposit was in the middle of the os penis. The deposit was as that of cementing the urethra and simple dislodging with probe or flushing was impossible. Hence repeated grating and curretting with the metal probe was carried out to establish patency. The procedure was accompanied by severe bleeding which was controlled by infusing adrenaline through the urethral orifice. A lignocaine gel lubricated catheter was then introduced into the bladder through the urethral orifice and fixed *in situ*. Intermittent bleeding was noticed in this animal and was controlled by instilling sterile haemocoagulase solution at the urethrotomy site.

Recurrence was noticed in two animals (D2 and D5) after five months and ten months of urethrotomy respectively. In animal D2 calculi was found in the urinary bladder and behind the os penis. Prescrotal urethrotomy was performed to remove the calculi. In animal D5, both cystic and urethral calculi were radiographically noticed. Cystotomy was performed to remove the cystic calculi and attempt was made to remove the urethral calculi by urohydropropulsion into the bladder, but could not remove, hence prescrotal urethrotomy was performed. A sterile catheter was introduced into the bladder through the urethral orifice and was fixed in position.

In all the operations blockage in the urethra could be relieved by surgery and catherterization through the normal urethral orifice was feasible. In D3 the urinary bladder was found to be highly congested with omental adhesion (Fig.23). Biopsy of urinary bladder from all the animals was performed which underwent cystotomy.

POST OPERATIVE MANAGEMENT

Post operatively all the animals were administered lactated Ringers' solution[1] @ 10 ml per kilogram body weight. Ampicillin cloxacillin @ 10 mg/kg body weight were injected intravenously and was continued for three days. From fourth day onwards specific antibiotic based on culture and sensitivity test was given (Table 6).

Urethrotomy and laparotomy wound was dressed with framycetin ointment until healing was complete. The suture applied to reduce the size of the skin wound were removed on the seventh day.

**Catheter Tolerance**

Catheter tolerance was poor in all the animals. Catheter was found removed on the same day itself by all the animals. No attempt was made to reintroduce the catheter.

**Healing of the Surgical Wound**

Healing of the surgical wound by granulation was good except in two animals (D1 and D8) which were subjected to post scrotal urethrotomy. Swelling around the surgical site and at the scrotal sac were observed on fourth day and was reduced by seventh day. In all these animals healing was complete when it was observed on $30^{th}$ day.

**Complications**

The only complication encountered was swelling and oedema of the scrotal sac seen in animal D1 and D8 where post scrotal urethrotomy was performed. In animal D2 and D7 swelling around the surgical site was noticed (Fig.24). In all these animals swelling was subsided after the application of magsulph glycerine paste on the swelling and framycetin ointment on the wound.

**Post Operative Bleeding**

In animal D4 and D7 bleeding was noticed during and after completion of the surgery. In animal D7 severe bleeding after surgery was observed due to injury to cavernous tissue while removing the calculi. The site was identified and the urethral edge was sutured with tunica albugenia and in animal D4 bleeding was controlled by administering ethamsylate one millilitre intramuscualar for two days.

RECURRENCE

Recurrence was observed in two animals (D2 and D5) after operation. In one animal (D2) recurrence was noticed after five months and in D5 after ten months. In both cases numerous cystic calculi were present when it was originally presented for treatment.

HAEMATOLOGICAL EVALUATION (Table 7)

**Total Erythrocyte Count (TEC)**

The mean total erythrocyte count ($10^6$/cu.mm) was 5.27 ± 0.09 before surgery and 5.36 ± 0.08 and 5.54 ± 0.09 on 7$^{th}$ and 30$^{th}$ day of surgery respectively. The observations on 30$^{th}$ post operative day revealed significant ($P \leq 0.05$) increase and reached normal.

**Total Leucocyte Count (TLC)**

The mean total leucocyte count ($10^3$/cu.mm) was 17.33 ± 0.71 before surgery and 15.32 ± 0.69 and 13.93 ± 0.65 on 7$^{th}$ and 30$^{th}$ day of surgery respectively. The observations on 30$^{th}$ post operative day revealed significant ($P \leq 0.05$) decrease and reached normal.

**Haemoglobin Concentration (Hb)**

The mean haemoglobin count (g/dL) was 10.47 ± 0.20 before surgery and 10.70 ± 0.206 and 11.09 ± 0.22 on 7$^{th}$ and 30$^{th}$ day of surgery respectively. The observations on 30$^{th}$ post operative day revealed significant ($P \leq 0.05$) increase and reached normal.

**Volume of Packed Red Cell (VPRC)**

The mean packed cell volume (%) was 31.56 ± 0.64 before surgery and 32.22 ± 0.49 and 33.89 ± 0.56 on $7^{th}$ and $30^{th}$ day of surgery respectively. The observations on $30^{th}$ post operative day revealed significant ($P \leq 0.05$) increase and reached normal.

**Erythrocyte Sedimentation Rate (ESR)**

The mean erythrocyte sedimentation rate (mm/h) was 13.44 ± 1.16 before surgery and 11.44 ± 1.20 and 9.11 ± 1.38 on $7^{th}$ and $30^{th}$ day of surgery respectively. The observations on $30^{th}$ post operative day revealed significant ($P \leq 0.05$) decrease and reached normal.

**Differential Leucocyte Count (DLC)**

The mean neutrophil count (%) was 81.22 ± 0.95 before surgery and 72.66 ± 1.39 and 70.33 ± 0.92 on $7^{th}$ and $30^{th}$ day of surgery respectively. The observations on $30^{th}$ post operative day revealed significant ($P \leq 0.05$) decrease and reached normal.

The mean lymphocyte count (%) was 15.89 ± 1.00 before surgery and 23 ± 1.49 and 24.33 ± 1.30 on $7^{th}$ and $30^{th}$ day of surgery respectively. The observations on $30^{th}$ post operative day revealed significant ($P \leq 0.05$) increase and reached normal.

The mean monocyte count (%) was 1.44 ± 0.37 before surgery and 2.44 ± 0.55 and 4 ± 0.64 on $7^{th}$ and $30^{th}$ day of surgery respectively. The observations on $30^{th}$ post operative day revealed significant ($P \leq 0.05$) increase and reached normal.

The mean eosinophil count (%) was 1.66 ± 0.23 before surgery and 1.44 ± 0.24 and 1.33 ± 0.29 on $7^{th}$ and $30^{th}$ day of surgery respectively. The observations on 30th post operative day revealed significant ($P \leq 0.05$) decrease and reached normal.

BIOCHEMICAL ANALYSIS (Table 8)

**Blood Urea Nitrogen (BUN)**

The mean blood urea nitrogen (mg/dl) was $42.06 \pm 4.12$ before surgery and $34.79 \pm 3.87$ and $27.68 \pm 2.91$ on 7th and 30th day of surgery respectively. The observations on 30th post operative day revealed significant ($P \leq 0.05$) decrease and reached normal.

**Serum Creatinine**

The mean serum creatinine (mg/dl) was $1.25 \pm 0.09$ before surgery and $0.904 \pm 0.06$ and $0.651 \pm 0.05$ on 7th and 30th day of surgery respectively. The observations on 30th post operative day revealed significant ($P \leq 0.05$) decrease and reached normal.

**Serum Sodium**

The mean serum sodium (mEq/l) was $133.67 \pm 2.45$ before surgery and $136.22 \pm 2.04$ and $139.56 \pm 1.78$ on 7th and 30th day of surgery respectively. The observations on 30th post operative day revealed significant ($P \leq 0.05$) increase and reached normal.

**Serum Phosphorous**

The mean serum phosphorus (mg/dl) was $5.39 \pm 0.21$ before surgery and $4.61 \pm 0.19$ and $3.82 \pm 0.19$ on 7th and 30th day of surgery respectively. The observations on 30th post operative day revealed significant ($P \leq 0.05$) decrease and reached normal.

**Serum Calcium**

The mean serum calcium (mg/dl) was 10.83 ± 0.54 before surgery and 9.85 ± 0.43 and 8.73 ± 0.28 on 7th and 30th day of surgery respectively. The observations on 30th post operative day revealed significant ($P \leq 0.05$) decrease and reached normal.

**Serum Potassium**

The mean serum potassium (mEq/l) was 5.84 ± 0.19 before surgery and 5.20 ± 0.12 and 4.32 ± 0.09 on 7th and 30th day of surgery respectively. The observations on 30th post operative day revealed significant ($P \leq 0.05$) decrease and reached normal.

URINALYSIS

**pH, colour and Consistency (Table 9)**

The pH of the urine ranged from 6.5 to 8, colour varied from straw coloured to dark red (blood tinged). Consistency of urine was turbid in all the animals except in animal D8 where collection of urine was not possible due to rupture of urinary bladder.

**Microscopic Examination**

On microscopic examination of urine, sediments were present in all the animals. In animal D5 crystals were present in the sediment and identified as triple phosphate and oxalate (Fig.25 and 26).

**Culture and Sensitivity**

In all animals urine samples showed growth of organism in Brain Heart Infusion Agar and was sensitive to different antibiotics. On staining of the culture of urine sample six animals showed Gram positive organism and five showed Gram negative organism. Sensitivity test revealed ciprofloxacin as most sensitive for both Gram positive and negative organism. Gram negative organism were sensitive to chloramphenicol followed by enrofloxacin and Gram positive for amoxicillin followed by amoxycillin.

CALCULI ANALYSIS

**Gross Appearance of Calculi (Fig.27)**

Dog No. 1

There was only a single calculus. It was greenish yellow ovoid in shape with rough surface. The calculus was 0.4 x 0.3 cm in size.

Dog No. 2

The calculus was more or less round, yellowish brown in colour with rough surface. Size of the calculus was 0.3 x 0.2 cm.

On recurrence, the calculi were in the form of yellow and brown coloured flakes with rough surface. Size varied from 0.1 to 0.2 cm.

Dog No. 3

There were three large calculi which were pyramidal in shape with smooth surface and off white in colour. Size of calculi varied from 1.5 cm x 1.5 cm to 1.5 cm x 2.00 cm on broader surface.

Dog No. 4

There were two calculi with a size of 0.5 x 0.4 cm. Deep yellow in colour. The surface of the calculi had a linear projection on one side resembling the petals of small flower. The other side of the calculi was smooth.

Dog No. 5

There were three moderately large calculi and numerous small calculi. Yellow in colour the largest had a size of 0.2 x 0.2 cm.

On recurrence after 10 month, there were several small and large ovoid calculi. Both having smooth surface and the colour was light yellow, size varied from 1.2 x 1.3 cm to 1.7 x 1 cm.

Dog No. 6

There were three large and three small calculi. Light yellow in colour with rough surface. Large calculi varied in size from 0.4 x 0.5 cm to 0.2 – 0.4 cm in diameter.

Dog No. 7

The calculi were yellowish brown in colour. Rough surface with small projections. The larger calculi had diameter of 0.7 x 1.5 cm.

Dog No. 8

There were six large calculi oval and flat in shape with smooth surface. Off white in colour. Size varied from 0.1 to 1.2 cm in diameter.

Dog No. 9

There were totally 14 calculi. All were brownish yellow in colour with smooth surface. The size varied between 0.2 to 0.5 cm in diameter.

Dog No. 10

There was only one solid calculusalong with organic matter. Grey in colour with rough surface. The size being 0.1 cm in diameter.

*Composition of* **Urolith (Table 10)**

Composition of the urolith were analysed by Atomic Absorption Spectroscopy. In seven animals (D1, D2, D4, D5, D6, D8 and D9) calcium formed the major component of calculi and in two animals D3 and D7 phosphorus was the major component. Magnesium formed the least. In animal D2 on recurrence the calculi was high in phosphorus and in animal D5 the calcium content was found to be doubled.

## HISTOPATHOLOGY

In animal D5 and D8 histopathology of the urinary bladder revealed infiltration of inflammatory cells in the submucosa and in animal D3 diffuse haemorrhage in the submucosa (Fig.28 and 29).

## ELECTRON MICROSCOPIC STUDY

Electron microscopic study of one calculi was conducted which revealed deposition of concreation around the nidus in a concentric rings of varying density (Fig.30 and 31). External surface of the calculi revealed porosity of varying diameter (Fig.32).

Table 1. Observations on age, breed and sex of the animals affected with urolithiasis

| Dog No. | Age (years) | Breed | Sex | Castrated/Spayed/ Intact |
|---|---|---|---|---|
| D1 | 3 | Pomeranian | Male | Intact |
| D2 | 11 | Labrador | Male | Intact |
| D3 | 8 | German Shepherd Dog | Female | Intact |
| D4 | 8 | Labrador | Male | Intact |
| D5 | 6 | Boxer | Male | Intact |
| D6 | 3 | German Shepherd Dog | Male | Intact |
| D7 | 4 | Dachshund | Male | Intact |
| D8 | 2 | Rottweiler | Male | Intact |
| D9 | 11 | Pomeranian | Male | Intact |
| D10 | 7 | German Shepherd Dog | Male | Intact |

Average 6.3 years

Table 2. Clinical signs exhibited by the animals under study

| Sl No | Animal No | General condition | Colour of the mucus membrane | Feed intake | Vomiting | Urination | Haematuria | Bladder distension |
|---|---|---|---|---|---|---|---|---|
| 1 | D1 | Active | Pale roseate | Reduced | Absent | Dribbling | Absent | Distended |
| 2 | D2 | Active | Slightly Congested | Reduced | Absent | Dribbling | Absent | Distended |
| 3 | D3 | Active | Congested | Reduced | Present | Dribbling | Present | Distended |
| 4 | D4 | Active | Pale roseate | Reduced | Absent | Dribbling | Absent | Distended |
| 5 | D5 | Active | Slightly congested | Reduced | Absent | Dribbling | Present | Distended |
| 6 | D6 | Active | Congested | Reduced | Absent | Dribbling | Present | Distended |
| 7 | D7 | Active | Pale roseate | Normal | Absent | Dribbling | Present | Distended |
| 8 | D8 | Dull and weak | Slightly congested | Reduced | Present | Absent | Absent | Distended |
| 9 | D9 | Active | Congested | Normal | Absent | Dribbling | Absent | Not distended |
| 10 | D10 | Active | Pale roseate | Reduced | Absent | Dribbling | Present | Distended |

Table 3. Rectal temperature, pulse rate and respiratory rate in dogs before and after surgery (Mean ± SE)

(n=10)

| Physiological parameters | Before surgery | After surgery | |
|---|---|---|---|
| | 1st day | 7th day | 30th day |
| Rectal temperature (°C) | 39.27 ± 0.08 | 39.20 ± 0.08 | 39.07 ± 0.09 |
| Pulse rate (per min) | 119.67 ± 4.42 | 113.22 ± 5.14 | 115.00 ± 3.92 |
| Respiratory rate (per min) | 50.22 ± 7.45 | 50.33 ± 6.05 | 51.00 ± 6.38 |

Table 4. Radiographic observation on the location of the calculi and its recurrence in animals

| Sl. No. | Animal No. | Location of the calculi | Recurrence after treatment |
|---|---|---|---|
| 1 | D1 | Ischial arch of urethra | Nil |
| 2 | D2 | Urinary bladder and groove of os penis | Recurrence noticed after five months |
| 3 | D2 | Calculi found in the urinary bladder and behind the os penis | Nil |
| 4 | D3 | Urinary bladder and neck of urinary bladder | Nil |
| 5 | D4 | Groove of os penis | Nil |
| 6 | D5 | Groove of os penis | Recurrence noticed after ten months |
| 7 | D5 | Calculi found in the urinary bladder and groove of the os penis | Nil |
| 8 | D6 | Groove of os penis | Nil |
| 9 | D7 | Groove of os penis | Nil |
| 10 | D8 | Urinary bladder and Ischial arch. | Nil |
| 11 | D9 | Urinary bladder and groove of os penis | Nil |
| 12 | D10 | Behind the os penis | Nil |

Table 5. Type of operations performed to remove obstruction in animals

| Sl. No. | Animal No. | Operation performed |
|---|---|---|
| 1 | D1 | Post scrotal urethrotomy |
| 2 | D2 | Prescrotal urethrotomy |
| 3 | D2 | Prescrotal urethrotomy on recurrence |
| 4 | D3 | Cystotomy |
| 5 | D4 | Prescrotal urethrotomy |
| 6 | D5 | Prescrotal urethrotomy |
| 7 | D5 | Cystotomy and Prescrotal urethrotomy on recurrence |
| 8 | D6 | Prescrotal urethrotomy |
| 9 | D7 | Prescrotal urethrotomy |
| 10 | D8 | Cystotomy and Postscrotal urethrotomy |
| 11 | D9 | Prescrotal urethrotomy |
| 12 | D10 | Prescrotal urethrotomy |

Table 6. Observations on culture and sensitivity test of urine collected during surgery and the antibiotic chosen for the treatment

| Animal No. | Culture and sensitivity | Antibiotic administered |
|---|---|---|
| D1 | Gram negative coccobacilli could be isolated sensitive to. Enrofloxacin (++), Oxytetracycline (+) Resistant to Chloramphenicol, Furasolidone, Nystatin and Amphotericin | Enrofloxacin (250 mg) ½ tab thrice daily for five days |
| D2 | Gram positive cocci and bacilli could be isolated. Sensitive to Chloramphenicol (++) Clotrimazole (++), Ciprofloxacin (+++), Enrofloxacin (++), Gentamicin (+), Ampicillin (+) | Ciprofloxacin (250 mg) 1 tab thrice daily for five days |
| D2 (recurrence) | Gram positive cocci could be isolated. Amoxycillin (+++), Enrofloxacin (++), Gentamycin (++) | Amoxycillin (250 mg) 1 tab thrice daily for five days |
| D3 | Gram positive cocci could be isolated. Sensitive to Enrofloxacin (+++), Ciprofloxacin (+++), Chloramphenicol (+++), Ampicillin (++), Clotrimazole (++), Gentamicin (++), | Enrofloxacin (250 mg) 1 tab thrice daily for five days |
| D4 | Gram negative coccobacilli could be isolated. Sensitive to Gentamicin (+), Enrofloxacin (+++), Ampicillin (++++), Furazolidone (++), Ciprofloxacin (+++) | Ampicillin (250 mg) 1 tab thrice daily for five days |
| D5 | Gram negative rods could be isolated. Sensitive to tetracycline (+) Amoxycillin (+++). Resistant to Penicillin V, Cephalexin, Cloxacillin. | Amoxycillin (250 mg) 1 tab thrice daily for five days |
| D5 (recurrence) | Gram negative coccibacilli could be isolated. Ciprofloxacin (+++), Ampicillin (++), Chloramphenicol (+) | Ciprofloxacin (250 mg) 1 tab thrice daily for five days |

| Animal No. | Culture and sensitivity | Antibiotic administered |
|---|---|---|
| D6 | Gram positive cocci could be isolated. Sensitive to Ciprofloxacin (+++), Chloramphenicol (+++), Oxytetracyclin (+++), Penicillin G (+++), Furazolidone (++), Nitrofurantoin (++) | Ciprofloxacin (250 mg) 1 tab thrice daily for five days |
| D7 | Gram positive cocci Ampicillin (+++), Ciprofloxacin (+++), Enrofloxacin (+) | Ampicillin (250 mg) 1 tab thrice daily for five days |
| D8 | Urine could not be collected due to the rapture of the urinary bladder | |
| D9 | Gram negative bacilli Ciprofloxacin (+++), Pefloxacin (++), Nitrofurazone. Resistant to Ampicillin, | Ciproflaxacin (250 mg) 1 tab thrice daily for five days |
| D10 | Gram positive cocci sensitive to Ampicillin (+++), Ciprofloxacin (++), Chloramphenicol (+) | Ampicillin (250 mg) 1 tab thrice daily for five days |

Table 7. Haemogram in dogs before and after surgery (Mean ± SE)

(n=10)

| Haemogram | Before surgery | After surgery | |
|---|---|---|---|
| | | 7th day | 30th day |
| Total erythrocyte count ($10^6$/cu.mm) | 5.27 ± 0.09 | 5.36 ± 0.08 | 5.54 ± 0.09* |
| Total leucocyte count ($10^3$/cu.mm) | 17.33 ± 0.71 | 15.32 ± 0.69 | 13.93 ± 0.65* |
| Haemoglobin concentration (mg/dl) | 10.47 ± 0.20 | 10.70 ± 0.20 | 11.09 ± 0.22* |
| Volume of Packed Red Cell (mm/dl) | 31.56 ± 0.64 | 32.22 ± 0.49 | 33.89 ± 0.56* |
| Erythrocyte sedimentation rate (mm/hr) | 13.44 ± 1.16 | 11.44 ± 1.20 | 9.11 ± 1.38* |
| Neutrophils (%) | 81.22 ± 0.95 | 72.66 ± 1.39 | 70.33 ± 0.92* |
| Lymphocytes (%) | 15.89 ± 1.00 | 23.00 ± 1.49 | 24.33 ± 1.30* |
| Monocytes (%) | 1.44 ± 0.37 | 2.44 ± 0.55 | 4.00 ± 0.64* |
| Eosinophils (%) | 1.66 ± 0.23 | 1.44 ± 0.24 | 1.33 ± 0.29* |

*Significant ($P \leq 0.05$)

Table 8. Biochemical evaluation of serum before and after surgery (Mean ± SE) (n=10)

| Serum biochemistry | Before surgery | After surgery | |
|---|---|---|---|
| | | 7th day | 30th day |
| Serum urea nitrogen (mg/dl) | 42.06 ± 4.12 | 34.79 ± 3.87 | 27.68 ± 2.91* |
| Serum creatinine (mg/dl) | 1.25 ± 0.09 | 0.90 ± 0.06 | 0.65 ± 0.05* |
| Serum sodium (mEq/l) | 133.67 ± 2.45 | 136.22 ± 2.04 | 139.56 ± 1.78* |
| Serum phosphorus (mg/dl) | 5.39 ± 0.21 | 4.61 ± 0.19 | 3.82 ± 0.19* |
| Serum calcium (mg/dl) | 10.83 ± 0.54 | 9.85 ± 0.43 | 8.73 ± 0.28* |
| Serum potassium (mEq/l) | 5.84 ± 0.19 | 5.20 ± 0.12 | 4.32 ± 0.09* |

* Significant ($P \leq 0.05$)

Table 9. Observations on urinalysis in animals on the day of surgery

| No. | Animal No. | pH | Colour | Consistency | Crystal |
|---|---|---|---|---|---|
| 1 | D1 | 7.5 | Yellow | Turbid | Absent |
| 2 | D2 | 6.5 | Straw coloured | Turbid | Absent |
| 3 | D2 (on recurrence) | 7 | Yellow | Turbid | Absent |
| 4 | D3 | 7 | Yellow | Turbid | Absent |
| 5 | D4 | 7.5 | Dark yellow | Turbid | Absent |
| 6 | D5 | 8 | Red (blood tinged) | Turbid | Present |
| 7 | D5 (on recurrence) | 7.5 | Dark yellow | Turbid | Absent |
| 8 | D6 | 7.5 | Dark yellow | Turbid | Absent |
| 9 | D7 | 7.5 | Yellow | Turbid | Absent |
| 10 | D8 | Urine could not be collected due to rupture of urinary bladder | | | |
| 11 | D9 | 7.5 | Dark yellow | Turbid | Absent |
| 12 | D10 | 7.5 | Dark yellow | Turbid | Absent |

Table 10. Observations on calcium, phosphorus and magnesium content present in the urolith collected from the affected animals

| Animal number | Calcium | Phosphorus | Magnesium |
|---|---|---|---|
| D1 | 14 | 2.48 | 0.95 |
| D2 | 8.25 | 3.31 | 0.15 |
| D2 (recurrence) | 7.2 | 24.03 | 2.88 |
| D3 | 34.0 | 66.2 | 6.88 |
| D4 | 34.1 | 2.76 | 0.10 |
| D5 | 14.75 | 1.93 | 0.07 |
| D5 (recurrence) | 32.5 | 3.56 | 1.2 |
| D6 | 5.55 | 1.38 | 0.05 |
| D7 | 2.95 | 5.52 | 0.02 |
| D8 | 41.21 | 35.5 | 8.5 |
| D9 | 4.3 | 2.48 | 0.02 |
| D10 | Could not analyze | | |

Fig.23 Congested urinary bladder with omental adhesion in animal D3

Fig.24 Odema of prepucial region observed in animal D7

Fig. 23

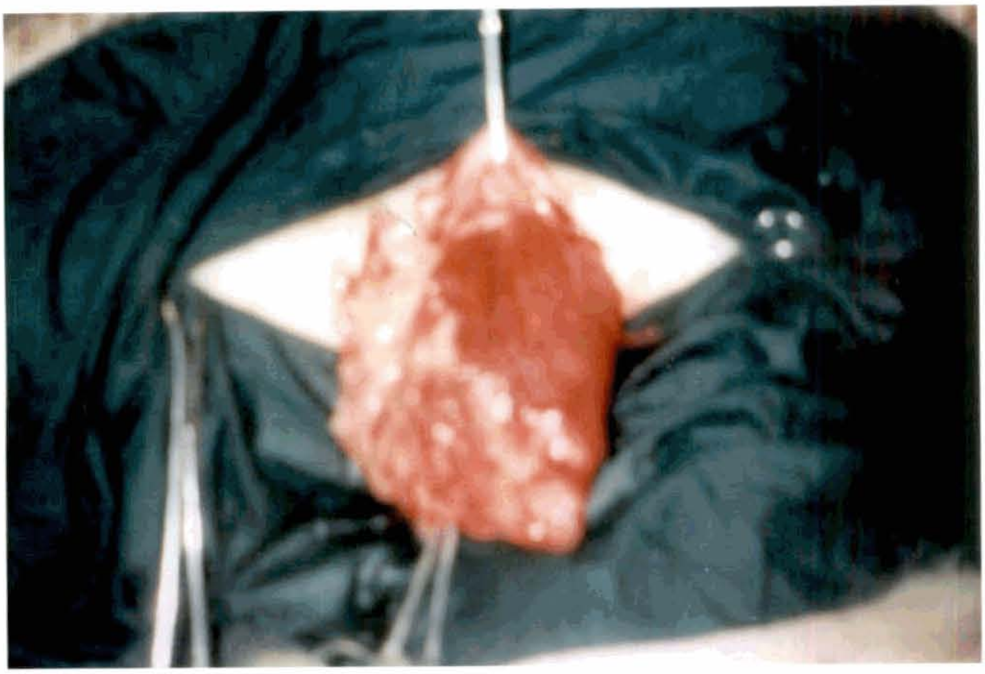


Fig. 24

**Fig.25 Urinary mixed crystals (calcium oxalate and triple phosphate) from urine sediment of animal D5 - 40x**

Fig.26 Urinary mixed crystals (calcium oxalate and triple phosphate) from urine sediment of animal D5 - Leishman stained 40x

Fig. 25

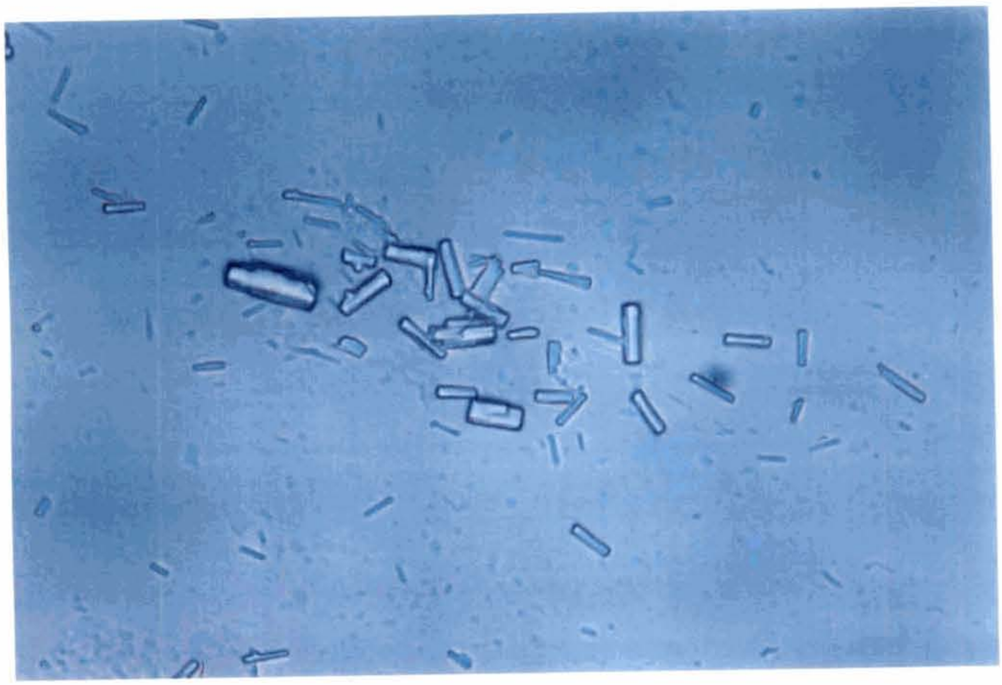


Fig. 26

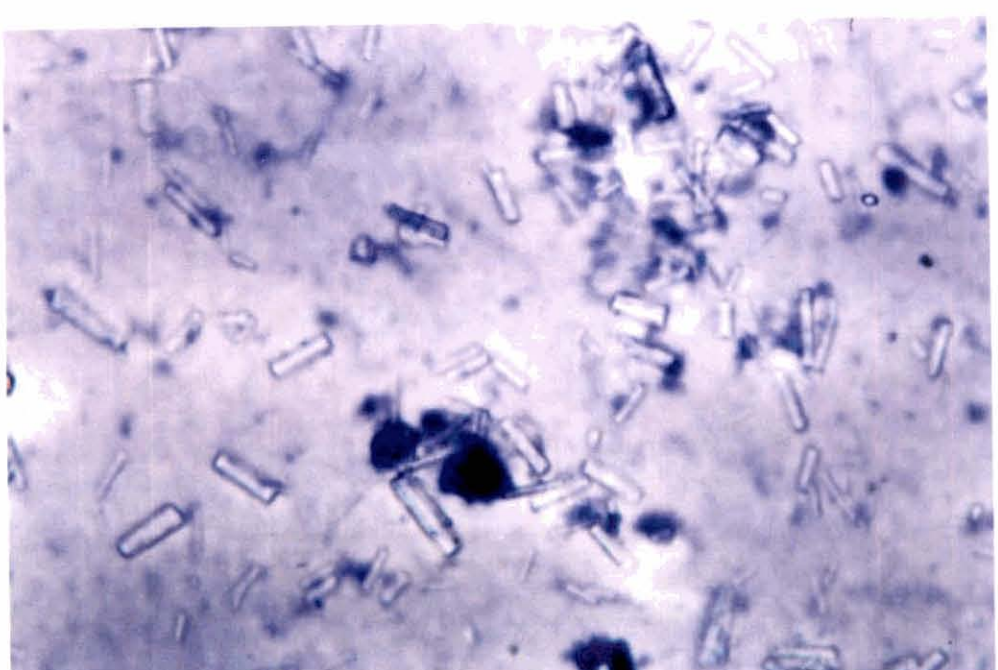


**Fig.27** **Gross appearance of each calculi removed from urethra and or urinary bladder from the animals under study**

Fig. 27

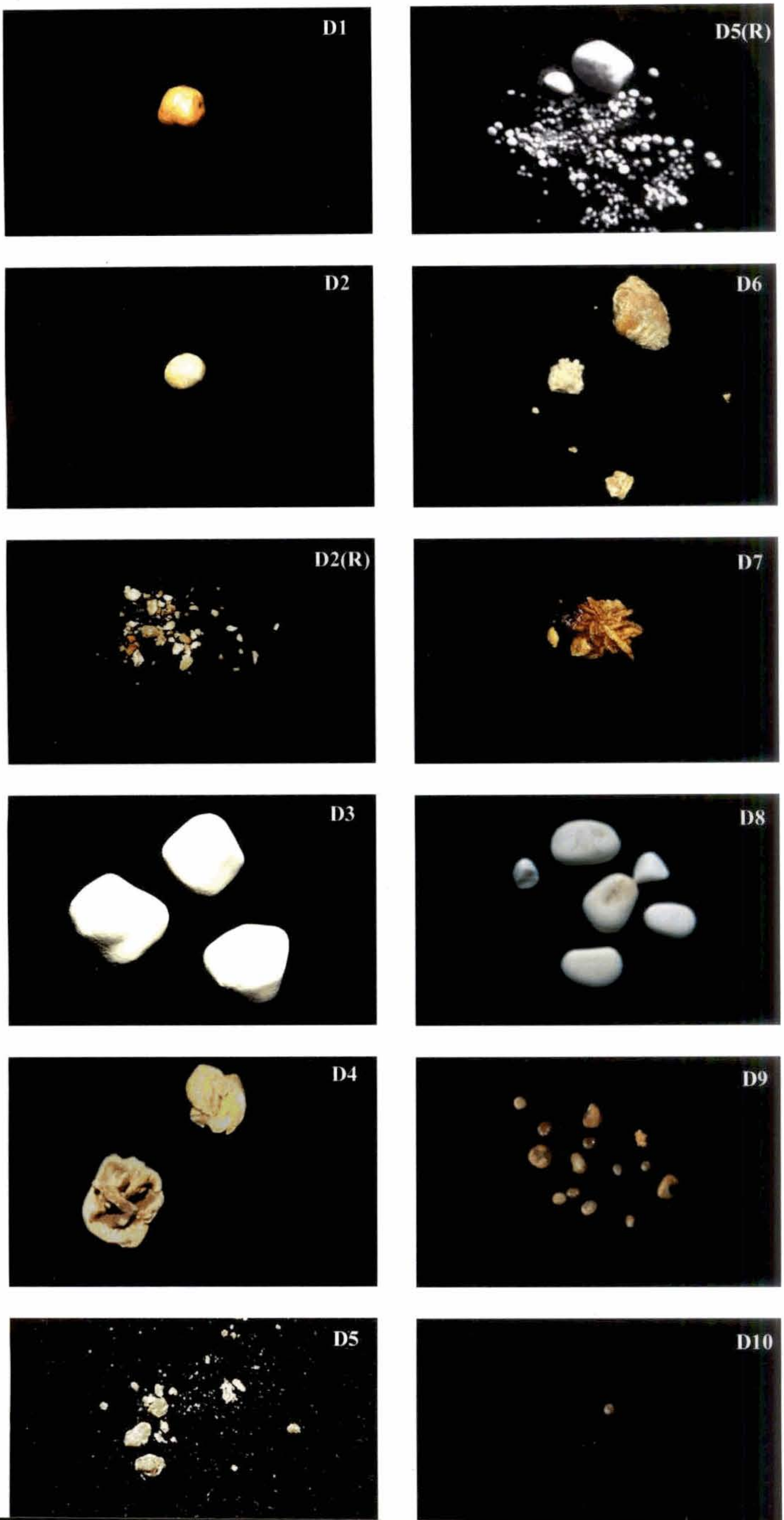


**Fig.28** **Infiltration of inflammatory cells in the submucosa of the urinary bladder of animal D5 - H & E staining 10x**

**Fig.29** **Diffuse haemorrhage in the submucosa in animal D3 – H & E staining 40x**

Fig. 28

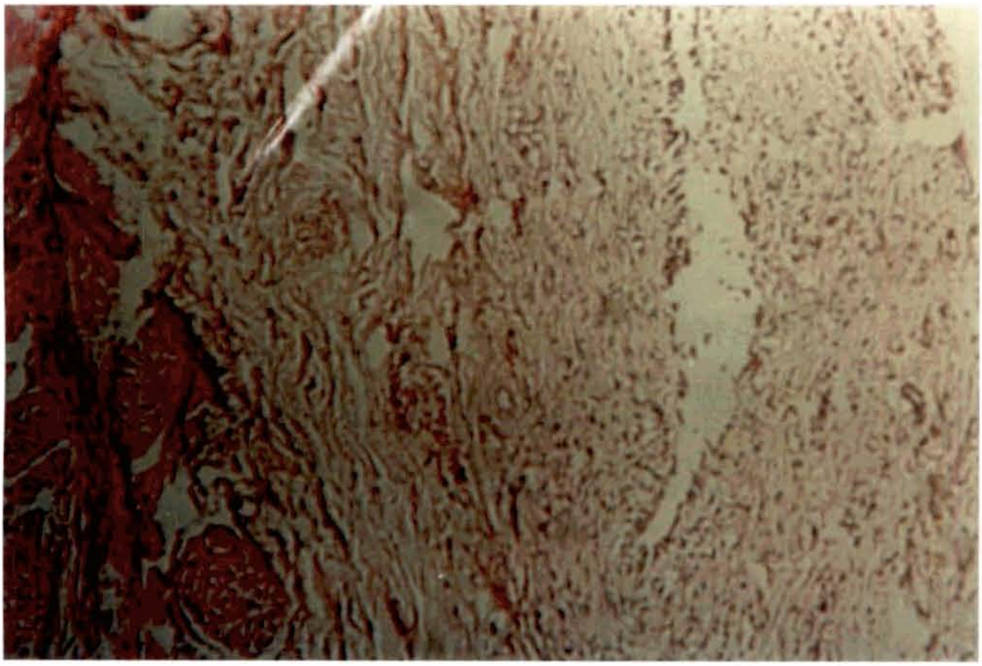


Fig. 29

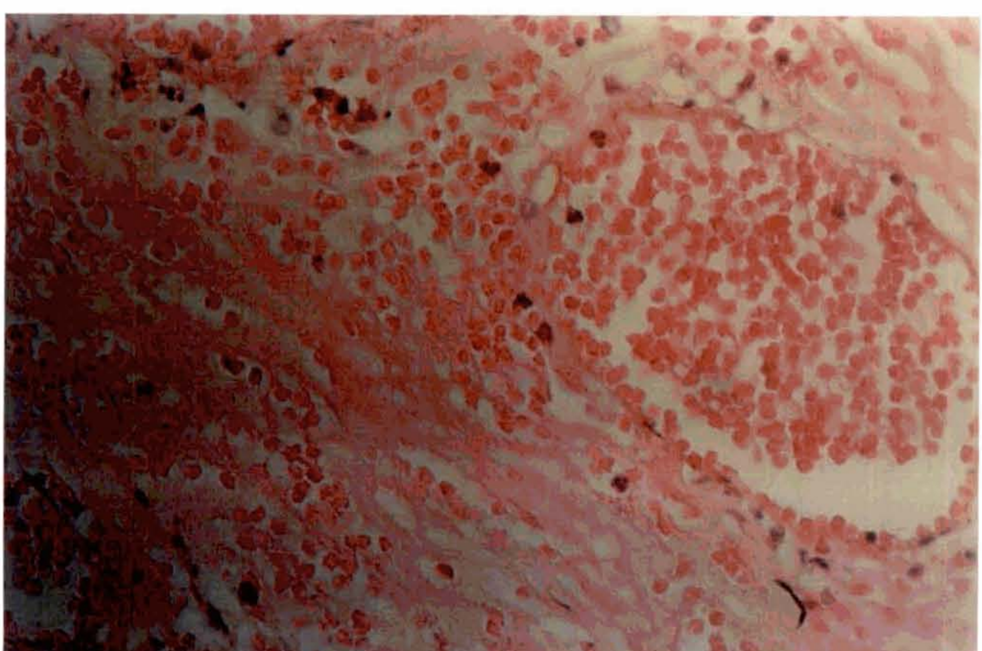


Fig.30 Electron microscopic study of calculus retrieved from animal D9 showing deposition of concretions around the nidus in a concentric rings of varying density at 500 um

Fig.31 Electron microscopic study showing nidus at the centre of the calculus at 20 um

Fig. 30

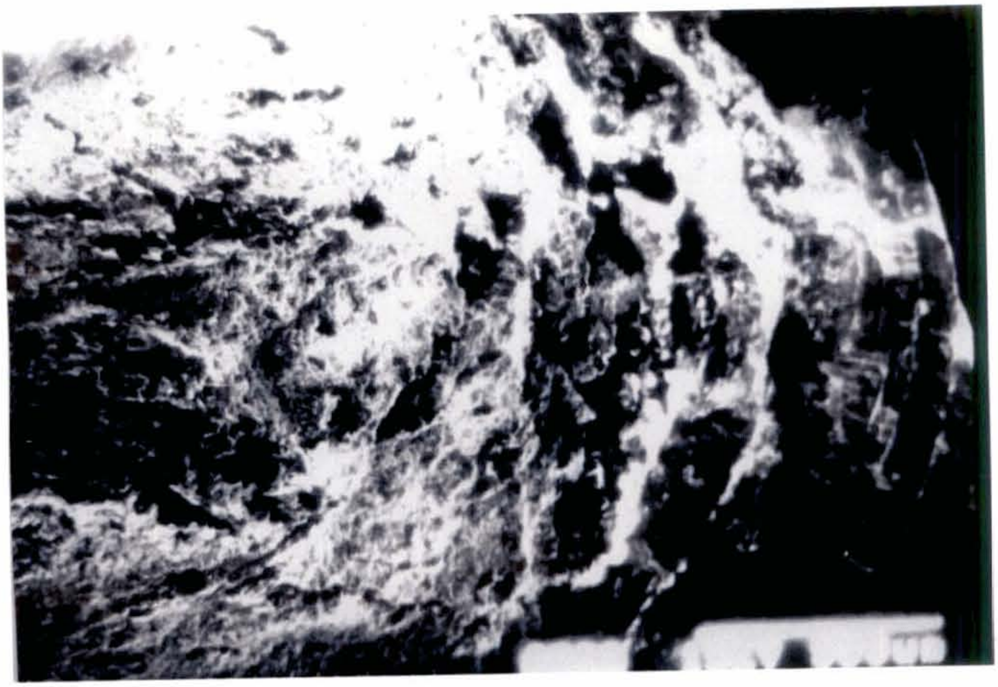


Fig. 31

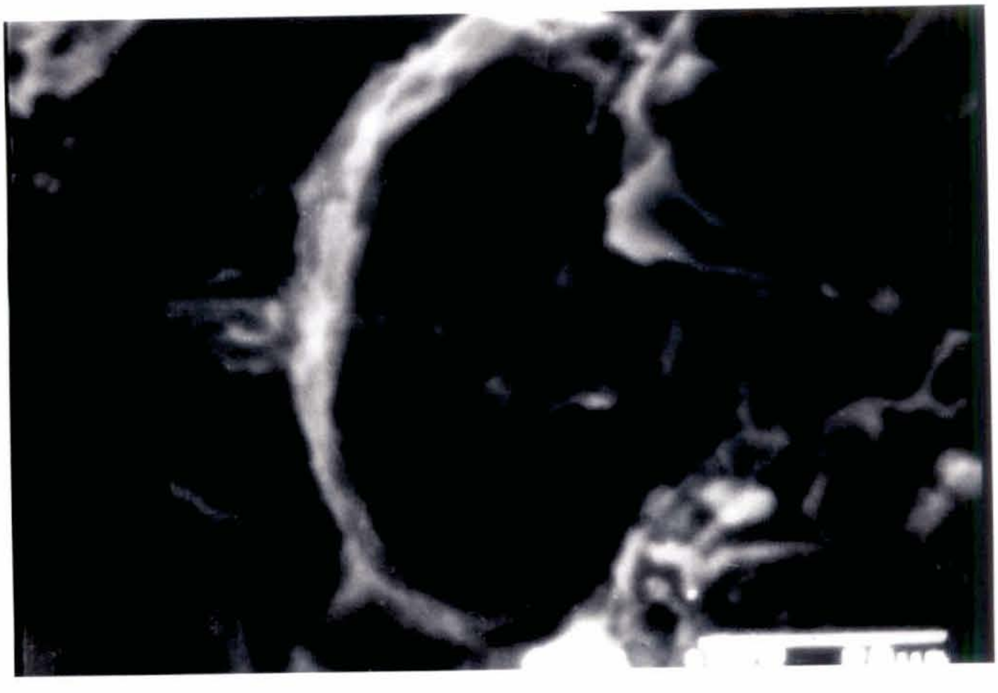
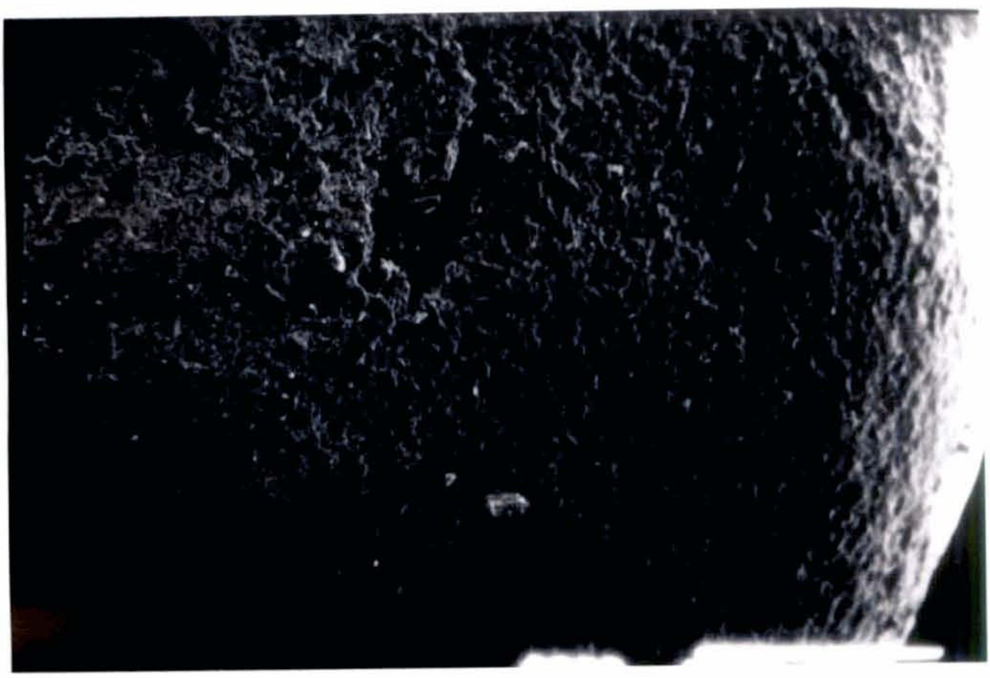


**Fig.32** **Electron microscopic study – Outer aspect of the calculus with porosity of varying diameter at 500 um**

Fig. 32



# *Discussion*

# DISCUSSION

Urolithiasis and subsequent obstruction of urinary tract is a relatively common problem in dogs. The severity of the urolithiasis depends on the anatomical location of the obstruction and whether the obstruction is acute/chronic, partial/complete. Complete obstruction of the urethra may result in over distension of the urinary bladder and reabsorption of retained pathological constituents and development of uremia. Hence removal of obstruction is of utmost importance in the treatment of obstructive urolithiasis.

In the present study ten clinical cases of urolithiasis in dogs had been evaluated for the incidence, etiology, pathology, surgical treatment and the post operative management.

## INCIDENCE

### Age

The mean age incidence of urolithiasis was 6.3 years. This is in accordance with Brodey (1955), Ling *et al.* (1998a), Ling *et al.* (1998b), Mok (2002) and Amarpal *et al.* (2004), where the age incidence reported as four months to 14 years, 6.9 years in males and 6.47 years in females, 6.67 years, three years and three to seven years respectively.

### Breed

Occurrence of urolithiasis was more in German Shepherd Dog (30 per cent ) followed by Pomerarian (20 per cent ), Labrador (20 per cent ), Boxer (10 per cent ), Dachshund (10 per cent ) and Rottweiler (10 per cent ). The highest incidence of urolithiasis had also been reported by Osborne *et al.* (1981a) and Aldrich *et al.* (1997).

**Sex**

Incidence of urolithiasis was more in male than in females. The high incidence of urolithiasis in male dogs in this study is in agreement with Brodey (1955), Schepper and Stock (1980), Osborne *et al.* (1981a), Lewis and Morris (1984), Wallerstorm and Wagberg (1992), Thilagar *et al.* (1996), Hesse *et al.* (1997), Lulich *et al.* (1999b), Lekcharoensuk *et al.* (2000), Sharma *et al.* (2001) and Mok (2002). The incidence of male animal is more due to the narrow and lengthy urethra and further narrowing of urethra in the groove of os penis which favours retention/lodgement of urolith (Sharma *et al.*, 2001).

CLINICAL SIGNS

Of the cases presented all were active except one animal, D8, which was dull and weak. In six animals (D2, D3, D5, D6, D8 and D9) conjunctival mucus membrane were congested. Appetite was reduced in eight animals (D1, D2, D3, D4, D5, D6, D8 and D10). Dribbling of the urine was the most prominent symptom except in one animal (D8) where there was no urination due to rupture of urinary bladder.

Posterior abdominal distension was palpable in all animals except one (D8). The urethral block in these cases was responsible for over distension of the bladder, resulting in posterior abdominal distension. Osborne *et al.* (1992) also reported enlarged abdomen in dogs affected with urethral calculi.

Haematuria was observed in five animals (D3, D5, D6, D7 and D10). Haematuria may be due to the constant irritation of the calculi on the urethral or cystic wall causing rupture of capillaries. This finding is in accordance with the findings of Brodey (1955), Klausner and Osborne (1979). Emesis was present in two animals (D3 and D8) which is in accordance with Schaer (1995).

RADIOGRAPHIC EVALUATION

In the present study the most common site of obstruction was in the groove of os penis followed by groove of os penis and bladder. The most common site of obstruction was reported as post os penis (Archibald and Owen, 1974 and Thilagar, 1996), bladder and urethra (Mok, 2002) and in the bladder (Nandi *et al.*, 2003 and Ling *et al.*, 1998a). Eventhough the common site of obstruction was found to be in the groove of os penis in the study, presence of calculi in the urinary bladder was also seen in 50 per cent of cases.

Out of the ten animals and 12 cases (including recurrence in two cases) the site of obstructions was at groove of the os penis (30.76 per cent), groove of os penis and bladder (23.07 per cent), just behind the os penis and bladder (15.38 per cent), ischial arch (7.69 per cent), just behind the os penis (7.69 per cent), ischial arch and bladder (7.69 per cent), urinary bladder and neck of bladder (7.69 per cent). The most common site of obstruction was in the groove of the os penis. This is in accordance with Finco and Rowland (1970), Patil *et al.* (1992) and Mok (2002).

SURGICAL APPROACH

Anaesthesia was found to be very satisfactory in all the animals. In all the animals removal of the calculi and re-establishment of the patency of the urethra was effective. Calculi present at the anterior and posterior to site of the obstruction was removed by flushing with normal saline. Gentle digital compression of the bladder favoured the dislodgement of the calculi as it exerts much pressure on the site of obstruction.

Calculi present in the groove of the os penis and behind the level of os penis could be removed by prescrotal urethrotomy. Calculi lodged at the ischial region required postscrotal urethrotomy since the calculi were much larger. In complete obstruction of the urethra, hydropropulsion into the bladder and

**Catheter tolerance**

In all the cases, removal of the catheter by the animal itself was seen. No difficulty in urination was noticed without reintroducing the catheter.

**Complications**

Scrotal oedema was observed in animals in which post scrotal urethrotomy was done, probably due to accumulation of fluid by gravitation.

Healing of wound was uneventful except in two animals were swelling around the surgical site was noticed due to seepage of urine.

In one animal (D7) the bleeding was due to accidental injury of the cavernous tissue during surgical manipulation was observed and was controlled by suturing the cavernous tissue to the urethral edge.

Complication of urethrotomy included urine scald, occasional bleeding in one animal D4 for few days and oedema at the prepucial and scrotal area. Post-operative haemorrhage was also been reported by Lewis and Morris (1984). Newton and Smeak (1996) reported the incidence of urine scald during post operative period.

RECURRENCE

Out of 10 cases of urolithiasis two showed recurrence. This may have been due to the minute calculi present in the urinary bladder and subsequent migration of calculi into the urethra. This agrees with Osborne *et al.* (1990).

The absence of recurrence in this study may be due to the flushing of urinary bladder during surgery, post operative intravenous administration of fluid, the selection of appropriate antibiotic for the treatment, administration of calculolytic drugs and alkalization of the urine.

## HAEMATOLOGICAL EVALUATION

### Total Erythrocyte Count

The total erythrocyte count was low before surgery which showed gradual increase on 7$^{th}$ and 30$^{th}$ post operative day. This is in accordance with Osborne *et al.* (1985). The decrease in erythrocyte count before surgery was due to haematuria.

### Total Leucocyte Count

There was leucocytosis with shift to left before surgery which reached towards normal by the 30$^{th}$ post operative day. It is a physiological response to combat the infection. Leukocytosis with neutrophilia was reported by Lulich *et al.* (1989).

### *Haemoglobin*

The reduced haemoglobin content observed in all cases of urolithiasis before surgery due to the haemorrhagic cystitis with haematuria which arises due to uroepithelial irritation. This is in agreement with the findings of Sharma (2001). It may also be due to stress. The haemoglobin content reached near normal value by the 30$^{th}$ post operative day indicating the restoration of normal functional status.

### Volume of Packed Red Cells

The volume of packed red cells was found to be low before surgery and reached towards normalcy by 30$^{th}$ post operative day. This is in accordance with Osborne *et al.* (1985). The reduced value may be due to systemic obstruction of the urine outflow and poor feed intake, stress induced in the system by the obstruction of the urine flow and subsequent changes.

**Erythrocyte Sedimentation Rate**

Erythrocyte sedimentation rate increased before surgery which gradually decreased to normal value by 30th post operative day. This is in accordance with Benjamin (2001) who reported an increase in erythrocyte sedimentation rate in association with infection.

**Differential Leucocyte Count**

The post operative examination revealed reduction in neutrophil which reached near normal by 30th post operative day. A neutrophilia with left shift had been reported by Lulich *et al.* (1989) in urinary calculi associated with infection.

BIOCHEMICAL ANALYSIS

**Blood Urea Nitrogen**

The serum urea nitrogen level was found elevated in all the cases before surgery. The increase in serum urea nitrogen seen in urolithiasis cases was in agreement with the findings of Benjamin (1985), DiBortala (1995), Grooters *et al.* (1997) and Flegel *et al.* (1998).

**Serum Creatinine**

The creatinine level was elevated before surgery in all animals and reached normal on 30th day. This is in accordance with the findings of Di Bartola (1995), Grooters (1997) and Flegel *et al.* (1998).

**Serum Sodium**

The serum sodium level decreased before surgery which attains normal level on 30th day. This is in accordance with Benjamin (2001).

**Serum Phosphorus**

The serum phosphorus level was elevated before surgery which attained normal level by 30th day. This is an agreement with Benjamin (1985), Osborne (1990) and Schaer (1995).

**Serum Calcium**

Serum calcium level was found to be increased before surgery but came down to normal on 30th day. This is in accordance with Benjamin (1985), Finco and Rowland (1970) and Osborne (1990).

**Serum Potassium**

The serum potassium level elevated before surgery which attained normal level by 30th day. This is in accordance with Benjamin (1985), Osborne (1990) and Schaer (1995).

The improvement in haemogram and biochemical evaluation on 7th and 30th post operative day indicated that surgical intervention helped in restoring normal biochemical and haematological status of the animal.

URINALYSIS

In the present study the pH observed was towards alkaline side. This is in agreement with the findings of Klausner and Osborne (1979), Brown *et al.* (1977a), Dowling (1996) and Ling *et al.* (1998d). Most calculi are commonly associated with urinary infection by urea splitting bacteria, the bacterial urease hydrolyses urea, leading to hyperammonuria.

The urine was turbid in all the animals and contained sediments. In animal D5 crystals were identified on microscopical examinations. The turbidity of the urine noticed in the present study was due to the presence of epithelial casts and crystals as a result of irritation by calculi and retention of urine. Borku *et al.*

(2000) also reported in the presence of urine sediments with red blood cell, white blood cell, epithelial debris, crystals in chronic renal failure.

**Organism Isolated**

Gram positive and Gram negative cocci and bacilli (Staphylococci, Streptococci, *E. coli)* were identified from the urine of affected dogs which were sensitive to specific antibiotic. Staphylococcal infection was most predominant. Most of the organisms was sensitive to ciprofloxacin followed by ampicillin and amoxicillin. This is in accordance with Finco *et al.* (1970), Clark (1974a), Weaver and Pillinger (1975), Brown *et al.* (1977a), Brown *et al.* (1977b), Osborne *et al.* (1981b), Bovee and McQuire (1984), Lewis and Morris (1984), Case *et al.* (1985), Case *et al.* (1993), Dowling (1996) and Ling *et al.* (1998d).

COMPOSITION OF UROLITHS

Composition of the urolith were analysed by Atomic Absorption Spectroscopy. In seven animals (D1, D2, D4, D5, D6, D8 and D9) calcium formed the major component of the calculi and in three animals (D3, D7 and D2 on recurrence) phosphorus was the major component. Magnesium formed the least. In animal D5 the calcium content was found to be doubled. Clark (1975) also reported variation in the composition of calculi on recurrence.

ELECTRON MICROSCOPIC STUDY

Electron microscopic study of the calculi revealed deposition of concretions around the nidus in concentric rings of varying density which is in accordance with Clark (1976). External surface of the calculi showed pores of different diameter. These findings were in accordance with Neuman *et al.* (1996).

# *Summary*

# SUMMARY

Ten clinical cases of canine urolithiasis were studied for age, breed and sex incidence, clinical signs, radiological evaluation, site of obstruction, type of surgery and its complications, urolith composition and recurrence.

All the animals were examined for the clinical signs exhibited and were subjected to radiography to locate the site of occurrence of urolith. These animals were subjected to urethrotomy or cystotomy according to the seat of obstruction except in two dogs where both urethrotomy and cystotomy were required to relieve obstruction.

During surgery urine samples were collected for analysis and culture and sensitivity. The urolith retrieved were analysed for its composition.

The mean age incidence was found to be 6.3 years. Out of the ten dogs three were German Shepherd Dogs, two each were Pomeranian and Labrador and one each Boxer, Dachshund and Rottweiler. Relatively, incidence was more in German Shepherd Dog followed by Pomeranian and Labrador. The incidence in Boxer, Dachshund and Rottweiler were comparatively less. Of the ten animals nine were males and one was female.

Out of ten animals one animal (D8) was dull and weak in appearance and all others were active. Difficulty in urination was reported in all the animals. Haematuria was present in five animals (D3, D5, D6, D7 and D10). Abdominal distention was noticed in nine animals. Palpation of the abdomen revealed distended urinary bladder in all animals except in one animal (D8) where bladder could not be clearly palpated and fluid thrill was felt on abdominal palpation indicating rupture of urinary bladder.

Lateral radiograph of the abdomen revealed moderate distension of urinary bladder in all animals except in one animal (D8) where shadow of urinary

bladder was not clear, suggestive of rupture of urinary bladder. Site of obstruction by the calculi was noticed at the ischial arch of urethra in two dogs (D1 and D8); groove of the os penis in six dogs (D2, D4, D5, D6, D7 and D9); behind the os penis in two dogs (D2 and D10); urinary bladder and urethra in five dogs (D2, D5, D8, D9 and D2 on recurrence). In one female dog (D3) calculi was noticed in urinary bladder and neck of the bladder.

Among the 14 operations in 10 animals, nine urethrotomy, two urethrotomy and cystotomy (four operations) and one cystotomy were performed. Prescrotal urethrotomy was carried out in seven animals (D2, D4, D5, D6, D7, D9 and D10) and post scrotal urethrotomy in two animals (D1 and D8). In D3 cystotomy was performed to remove cystic calculi. In one animal (D8) cystotomy was performed but it required post scrotal urethrotomy to remove calculi at ischial arch since the hydropropulsion was not effective. In animals with recurrence, urethrotomy was performed in animal D2 and urethrotomy and cystotomy in animal D5.

The study revealed that relieving obstruction by surgical correction was effective as it ensures immediate relief of obstruction and stress. Urethrotomy was found to be satisfactory in removing urethral calculi and compression and flushing of bladder enabled to remove small cystic calculi through the urethrotomy incision. Cystotomy was required to remove large cystic calculi.

The pH of the urine collected during surgery ranged from 6.5 to 8 and colour varied from straw coloured to dark red. Consistency of the urine in all animals was turbid. In animal D8 collection of urine was not possible due to rupture of urinary bladder.

On microscopical examination of urine, sediments were present in all the animals. In animal D5 crystals were present and were identified as triple phosphate and oxalate.

In all animals urine samples showed growth of microorganisms which were sensitive to cirpofloxacin followed by ampicillin and amoxycillin.

Catheter tolerance was poor in all the animals. Catheter was found removed on the same day itself by all the animal.

Healing of the surgical wound by granulation was good except in two animals (D1 and D8). Swelling around the surgical site and at the scrotal sac was noticed in these animals which were subjected to post scrotal urethrotomy.

The complicationsencountered were swelling and oedema of the scrotal sac seen in animals D1 and D8 where post scrotal urethrotomy was performed.

In animals D4 and D7 bleeding was noticed during and after completion of the surgery. In animal D7 bleeding was due to injury to cavernous tissue which was sutured to control the bleeding and in animal D4 bleeding was controlled by administering ethamsylate 1 ml intramuscular for two days.

Recurrence was observed in two cases (20%) where the urethrotomy was performed. In these cases cystic calculi were also present when initially presented for treatment.

The haematological examination showed low haemoglobin count, erythrocyte count and volume of packed red cells in all cases before surgery which increased significantly and reached towards normal by $30^{th}$ post operative day. There was leucocytosis with shift to left and increase in erythrocyte sedimentation rate which decreased significantly by 30th day and reached near normal value.

The biochemical examination showed high blood urea nitrogen, serum creatinine, phosphorus, calcium and potasium in all cases before surgery which decreased significantly by $30^{th}$ day. Serum sodium before surgery was low which increased by $30^{th}$ day.

Composition of the urolith were analysed and in seven dogs (D1, D2, D4, D5, D6, D8 and D9) calcium formed the major component of the calculi and in three dogs (D3, D7 and D2 on recurrence) phosphorus was the major component. Magnesium formed the least. In animal D2 on recurrence the caluli was high in phosphorus and in animal D5 the calcium content was found to be doubled.

Histopathologial study of the urinary bladder revealed inflammation and haemorrhage in the submucosa indicating chronic irritation and injury produced by the calculi to the bladder wall.

Electronmicroscopic study of one of the calculi (D9) was conducted which revealed deposition of concretions around the nidus in concentric rings of varying density and the surface of the calculi showed porosity with varying diameter.

From the study following conclusions were drawn:

Urolithiasis is more common in male dogs than in females.

German Shepherd Dog is more affected than the other breeds.

Obstruction is more in the urethra, with most common seat of obstruction in the groove of os penis.

The urethral obstruction could be relieved in all the animals by urethrotomy.

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

Flushing of the bladder and gentle compression facilitated expulsion of epithelial cast and smaller calculi lodged in the urinary bladder.

Culture and sensitivity of urine revealed presence of microorganisms associated with urolithiasis and was more sensitive to ciprofloxacin followed by ampicillin and amoxycillin than other antibiotics.

The composition of the uroliths revealed calcium as the major component followed by phosphorus.

Recurrence reported was 20 per cent, which may be due to the migration of cystic calculi present initially.

The bladder flushing during surgery, administration of diuretics, alkaliser and appropriate antibiotics of choice are found effective in reducing recurrence of the condition.

# References

# REFERENCES

Abdullahi, S.U. and Adeyanju, J.B. 1987. Medical dissolution of ammonium urate urolith in a dog. *Mod. Vet. Pract.* 20: 438

*Ahmed, I.H., Zeid, S.M.A., Hassan, M.M. 1998. Sonographic study on some urinary surgical affections in pet animals. *Assuit Vet. Med. J.* 38: 1-15

Aldrich, J., Ling, G.V., Ruby, A.L., Johnson, D.L. and Franti, C.E. 1997. Silica containing urinary calculi in dogs (1981-1993). *J. Vet. Inter. Med.* 11:288-295

Amarpal, Kinjavdekar, P., Aithal, H.P., Pawde, A.M., Singh, T. and Pratap .K. 2004. Incidence of urolithiasis: A retrospective study of five years. *Indian J. Anim. Sci.* 74: 175-177

Archibald, J. and Omen, R. 1974. Urinary System, *Canine Surgery.* Second edition. (eds. Alexander, J.E., Dingwall, J.S., Downie, H.G., Hulland, T.J., McDonell, W.N. and Sack, W.O.) American Veterinary Publication Inc., California, pp. 629-700

Bancroft, J.D. and Cook, H.C. 1984. *Manual of Histological Techniques.* Churchill Livingstone, Edinburg, London, 19 p.

Bartges, J.W., Osborne, C.A., Felice, L.J., Fletcher, T.F., Lulich, J.P. and Chen, M. 1996. Effects of various methods of preservation on the stability of uric acid in frozen canine urine. *Am. J. Vet. Res.* 57: 787-790

Bartges, J.W., Osborne, C.A., Lulich, J.P., Unger, L.K., Koehler, L.A., Bird, K.A., Clinton, C.W. and Davenport, M.P. 1994. Prevalence of cystine and urate uroliths in Bull Dog and urate uroliths in Dalmatian. *J. Vet. Med. Assoc.* 204: 1914-1918

Benjamin, M.M. 2001. *Outline of Veterinary Clinical Pathology.* Third edition. Kalyani Publishers, New Delhi, 351 p.

Bhatt, G.L. and Bijoor, D.V. 2003. Use of helical stone basket for the removal of urinary calculi in dogs. *Pet India* 10: 18

*Borku, M.K., Kurtdele, A., Aydin, Y., Durgut, R., Pekkaya, S. and Ozkantar, Y. 2000. Clinical laboratory and pathological findings in cats and dogs exhibiting chronic renal failure signs. *Ankara Universitesi Veteriner Fakultesi Dergisi.* 47: 281-289

Bovee, K.C. 1986. Canine cystine urolithiasis. *Vet. Clin. North Am. Small Anim. Pract.* 16: 211-215

Bovee, K.C. and McGuire, T. 1984. Qualitative and quantitative analysis of uroliths in dogs: definitive determination of chemical type. *J. Am. Vet. Med. Assoc.* 185: 983-987

Bowles, M.H., Welsh, R.D., Hoffman, J. and Turnwald, G.H. 2000. Evaluation of a method using *Proteus mirabilis* and *Pseudomonas aerogeinosa* to experimentally induced dual infection of the urinary bladder in dogs. *Am. J. Vet. Res.* 61: 1484-1486

Brodey, R.S. 1955. Canine urolithiasis. : A survey and discussion of fifty two clinical cases. *J. Am. Vet. Med. Assoc.* 126: 1-9

Brodey, R.S., Thomson, R., Sayer, P. and Eugster, B. 1977. Silicate renal calculi in Kenyan dogs. *J. Small Anim. Pract.* 18: 523-528

Brown, N.O., Parks, J.L. and Greene, R.W. 1977a. Canine urolithiasis: Retrospective analysis of 438 cases. *J. Am. Vet. Med. Assoc.* 170: 414-418

Brown, N.O., Parks, J.L. and Greene, R.W. 1977b. Recurrence of canine urolithiasis. *J. Am. Vet. Med. Assoc.* 170: 419-422

*Bumin, A. and Temizsoylu, D. 2000. Radiographic and ultrasonographic diagnosis and surgical removal of cystic calculi in dogs. *Ankara Universitesi Veteriner Fakultesi Dergisi* 47: 213-221

Cartee, R.E., Hudson, J.A. and Finn-Bodner, S. 1993. Ultrasonography. *Vet. Clin. North Am. Small Anim. Pract.* 23: 345-377

Case, L.C., Ling, G.V., Biberstein, E.L., Ruby, A.L. and Jang, S.S. 1985.Staphylococci in canine urolithiasis: species, identification using a commercially available tray micro method. *Am. J. Vet. Res.* 46: 238-241

Case, L.C., Ling, G.V., Franti, C.E., Ruby, A.L., Stevens, F. and Johnson, D.L. 1992. Cystine containing urinary calculi in dogs: 102 cases (1981-1989). *J. Vet. Med. Assoc.* 201: 129-133

Case, L.C., Ling, G.V., Ruby, A.L., Johnson, D.L., Franti, C.E. and Stevens, F. 1993. Urolithiasis in Dalmatians: 275 cases (1981-1990). *J. Am. Vet. Med. Assoc.* 203: 96-100

Clark, T.P. and Panciera, R. 1992. Calcium phosphate urolithiasis and renal dysplasia in a young dog. *J. Am. Vet. Med. Assoc.* 200: 1509-1511

Clark, W.T. 1975. Recurrence of urinary calculi in dogs. *Mod. Vet. Pract.* 7: 105

Clark, W.T. 1974a. Staphylococcal infection of the urinary tract and its relation to urolithiasis in dogs. *Vet. Rec.* 95: 204-206

Clark, W.T. 1974b. Distribution of canine urinary calculi and their recurrence following treatment. *J. Small Anim. Pract.* 15: 437-444

Clark, W.T. 1976. The structure of canine urinary calculi. *J. Small Anim. Pract.* 17: 575-581

Comer, K.M. and Ling, G.V. 1981. Results of urinalysis and bacterial culture of canine urine obtained by antepubic cystocentesis, catheterization and the mid stream voided methods. *J. Am. Vet. Med. Assoc.* 179: 891-894

DiBartola, S.P. 1995. Clinical approach and laboratory evaluation of renal disease. *Textbook of Veterinary Internal Medicine.* (Eds. Ettinger, S.J. and Feldman, E.C.). W.B. Saunders, Philadelphia, pp. 1706-1719

Dowling, M.P. 1996. Antimicrobial therapy of urinary tract infections. *Can. Vet. J.* 37:438-441.

Dyce, K.M., Sack, W.O. and Wensing, C.J.G 1996. *Textbook Veterinary Anatomy.* W.B. Saunders Company, Philadelphia, 1198 p.

*Ehrhart, L.A. and McCullagh, K.G. 1973. Silica urolithiasis in dogs fed with atherogenic diet. Proceedings of the Society for Experimental Biology and Medicine 143: 131-132

Escolar, E., Bellanato, J. and Medina, J.A. 1990. Structure and composition of canine urinary calculi. *Res. Vet. Sci.* 49: 327-333

Escolar, E., Bellanato, J. and Rodriguez, M. 1991. Study of cystine urinary calculi in dogs. *Can. J. Vet. Res.* 55: 67-70

*Felkai, C., Voros, K., Vrabely, T., Vetesi, F., Karsai, F., Papp, L. 1997. Ultrasonographic findings of renal dysplasia in Cocker Spaniels (eight cases). *Acta Veterinaria Hungarica* 45: 397-408

*Fettman, M.J.1988. Proceedings of the Annual Veterinary Medical Forum American College of Veterinary Internal Medicine, Washington, D.C., 688 p.

Finco, D.R. and Rowland, G.N. 1970. Hypercalcaemia secondary to chronic renal failure in the dogs – A report of four cases. *J. Am. Vet. Med. Assoc.* 173: 990-994

Flegel, T., Freistadt, R. and Haider, W. 1998. Xanthine urolithiasis in a Dachshund. Vet. Rec. 143: 420-423

Fluckiger, M. 1991. Ultrasonographic diagnosis in dogs and cats. Clinical application – an overview. *Schweizer-Archiv-fur-Tierheilkunde.* 133: 101-111

Franti, C.E., Ling, G.V., Ruby, A.L. and Johnson, D.L. 1999. Urolithiasis in dogs V: Regional comparisons of breed, age, sex, anatomic location and mineral type of calculus. *Am. J. Vet. Res.* 60: 29-42

Grauer, G. and Lane, F. 1995. Complicated urinary tract infection in dog. *J. Anim. Hosp. Assoc.* 32: 44-47

*Grodzki, K., Klopocki, T., Lechowski, R and Wyrzykowski, R. 1981. Urinary lysozyme as an indicator of kidney damage during some disease of dog *Medycyna-Weternaryjna.* 37: 349-351

Grooters, A.M. 1997. Renomegaly in dogs and cats. Part II - Diagnostic approach. *Compend.* 19: 1213-1229

Guly, U.M. and Turney, J.H. 1990. Post traumatic acute renal failure, 1956-1988. *Clin. Nephrol.* 39: 79

Harshney, L.C., Singh, H., Dabas, Y.P.S. and Joshi, H.C. 1988. Cystic calculi in bitch – a case report. *Indian J. Vet. Med.* 8: 26-27

*Hesse, A. and Bruhl, M. 1988. Cystine urolithiasis in the dog. *Effem-Forschung-Fur-Heimtiernahrung* 27: 21-27

*Hesse, A., Steffes, H.J., Graf, C., Bongartz, D. and Albercht, F. 1997. Composition of canine urinary stones and their occurrence in different breeds. *Berliner-Und-Munchener-Tierarztliche-Wochenschrift.* 110: 11-12

Hoff, M.E. 1986. Dietary management of struvite cystic calculi in a dog. *Mod. Vet. Pract.* 90: 883-886

Hoppe, A., Denneberg, T., Jeppsson, J.O. and Kagedal. 1993. Canine cystinuria: An extended study on the effects of 2-mercapto propionyl glycine on cystine urolithiasis and urinary cystine excretion. *Br. Vet. J.* 149: 235-251

Houston, D.M., Moore, E.P., Favrin, M.G. and Hoff, B. 2004. Canine Urolithiasis: a look at over 16,000 urolith submissions to the Canadian Veterinary Urolith Centre from February 1998 to April 2003. *Can. Vet. J.* 45: 225-230

*Idowu, A.L., Atilota, M.A.O. and Bobade, P.A. 1983. Canine urolithiasis in Ibadan, Nigeria. *Trop. Vet.* 193: 146-150

Jones, B.R., Eluk, O.A.J., Larkin, H. and Rogers, K.D. 2001. Canine uroliths: analysis of uroliths from dogs in Ireland. *Irish Vet. J.* 54: 629-632

Jones, B.R., Kirhman, J.H., Hogan, J. and Hohmes, S. 1998. Analysis of uroliths from cats and dogs in New Zealand. *New Zealand Vet. J.* 46: 233-236

Klausner, J.S. and Osborne, C.A. 1979. Dissolution of struvite nephrolith in a dog. *J. Am. Vet. Med. Assoc.* 174: 1100-1104

Klausner, J.S., O'leary, T.P. and Osborne, C.A. 1987. Calcium urolithiasis in two dogs with parathyroid adenomas. *J. Am. Vet. Assoc.* 191: 1423-1426

Klausner, J.S., Osborne, C.A. and Griffith, J.P 1981.Animal model of human disease: Canine struvite urolithiasis. *Am. J. Pathol.* 102: 457-458

*Kobrink, H.M. 1986. Surgically removed bladder and urinary calculi in dogs and cats and their composition. *Tierarztliche – Umschau.* 41: 553-555

Krawiec, D.R., Osborne, C.A., Leininger, J.R. and Griffith, D.P. 1984a. Effect of acetohydroxamic acid on dissolution of canine struvite uroliths. *Am. J. Vet. Res.* 45: 1266-1275

Krawiec, D.R., Osborne, C.A., Leininger, J.R. and Griffith, D.P. 1984b. Effect of acetohydroxamic acid on prevention of canine struvite urolith. *Am. J. Vet. Res.* 45: 1276-1283.

*Kruzik, P., Rautsckha, R. and Weiser, M. 1991. Urolith in dogs: Chemical composition and determination of selected trace elements. *Wiener-Tierarzthiche-Monetsschrift* 78: 408-413

Lekcharoensuk, C., Osborne, C.A., Lulich, J.P., Pusoonthornthum, R., Kirk, C.A., Ulrich, L.K., Kochler, L.A., Carpenter, K.A. and Swanson, L.L. 2002a. Association between dry dietary factors and canine calcium oxalate urolith. *Am. J. Vet. Res.* 63: 330-337

Lekcharoensuk, C., Osborne, C.A., Lulich, J.P., Pusoonthornthum, R., Kirk, C.A., Urich, Koehler, L.A., Carpenter, K.A. and Swanson, L.L. 2002b. Association between dietary factors in canned food and formulation of calcium oxlate uroliths in dogs. *Am. J. Vet. Res.* 63: 163-169

Lekcharoensuk, C., Osborne, C.A., Lulich, T.J.P., Pusoonthornthum, R. and Kirk, C.A. 2001. Association between dietary factors and calcium oxalate and magnesium ammonium. *J. Am. Vet. Med. Assoc.* 219: 1228-1237

Lekcharoensuk, C., Osborne, C.A., Pousoonthronthum, R., Allen, T.A., Keehler, L.A., Urlich, L.K., Carpenter, K.A. and Swanson, L.L. 2000. Patient and environmental factors associated with calcium, oxalate urolithiasis in dogs. *J. Am. Vet. Med. Assoc.* 217: 515-519

Lewis, D.L. and Morris, M.L. 1984. Canine Urolithiasis: Diagnosis and Treatment. *Mod. Vet. Pract.* 17: 375-378

*Lewis, L.D. 1989. Feeding as an aid in the treatment of urolithiasis in dogs. *Recueil-de- Medicine Veterinaire* 165: 665-677

Ling, G.V., Franti, C.E., Ruby, A.L., Johnson, D.L. and Thurmod, M. 1998a. Urolithiasis in dogs I : Mineral prevalence and interrelations of mineral composition, age and sex. *Am. J. Vet. Res.* 59: 624-629

Ling, G.V., Franti, C.E., Ruby, A.L. and Johnson, D.L. 1998b. Urolithiasis II: Breed prevalence and interrelations of breed, sex, age and mineral composition. *Am. J. Vet. Res.* 59: 630-642

Ling, G.V., Franti, C.E., Johnson, D.L. and Ruby, A.L. 1998c. Urolithiasis in dogs III: Prevalence of urinary tract infection and interrelations of infection age, sex and mineral composition. *Am. J. Vet. Res.* 59: 643-649

Ling, G.V., Franti, C.E., Johnson, D.L. and Ruby, A.L. 1998d. Urolithiasis in dogs IV: Survey of interrelations among breed, mineral composition, and anatomic location of calculi and presence of urinary tract infection. *Am. J. Vet. Res.* 59: 650-660

Ling, G.V., Ruby, A.L., Johnson, D.L., Thurmond, M. and Franti, C.E. 1998e. Renal calculi in dogs and cats: prevalence, mineral type, breed, age and gender interrelationships (1981-93). *J. Vet. Inter. Med.* 12: 11-21

Ling, G.V., Ruby, A.L., Harrold, D.R. and Johnson, D.L. 1991. Xanthine containing urinary calculi in dogs given allopurinol. *J. Am. Vet. Med. Assoc.* 198: 1935-1940

Lulich, J.P. and Osborne, C.A. 1992. Effects of chlorothiazide on urinary excretion of calcium in clinically normal dogs. *Am. J. Vet. Res.* 53: 2328-2332

Lulich, J.P., Osborne, C.A., Thumchai, R., Lekcharoensuk, C., Ulrich, L.K., Koehler, L.A., Bird, K.A, Swanson, L.L. and Nakagawa, Y. 1999a. Epidemiology of canine calcium oxalate uroliths. *Vet. Clin. North Am. Small Anim. Pract.* 29: 113-122

Lulich, J.P., Osborne, C.A., Lekcharoensuk, C., Allen, T.A. and Nakagawa, Y. 1999b. Canine calcium oxalate urolithiasis. *Vet. Clin. North Am. Small Anim. Pract.* 29: 123-139

Lulich, J.P., Osborne, C.A., Parker, M.L., Clinton, C.W. and Davenport, M.P. 1989. Compound urolith : Treatment and prevention. *Kirk's Current Veterinary Therapy* X. Tenth edition (eds. Bonagura, J.D. and Kirk, W.R.) Philadelphia,W.B. Saunders, pp. 1182-1184

Makkena, S., Harikrishna, N.V.V. and Rao, K.V. 1999. A case of cystic calculi in a bitch. *Indian Vet. J.* 76: 728-729

Mitra, A.K., Bose, V.S.C., Ray, A.K. and Nayak, S. 1989. Urethral calculi in dogs treated by cystotomy and retrograde hydropropulsion. *Indian J. Vet. Surg.* 10: 138-139

Mok, J.S. 2002. Urolithiasis in dogs: Comparison of breed, gender, anatomic location, urinalysis and mineral composition of calculus (30 cases). *J. Vet. Clin.* 19: 272-275

Morris, M.L. and Doering, G.G. 1978. Diet and canine urolithiasis. *Canine Practice.* 5: 53-59

Nandi, S., Chakrabarti, A. and Lodh, C. 2003. Prevalence of canine urolithiasis in and around Kolkata. *Indian J. Vet. Med.* 23: 38-39

Neuman, R.A.D., Ruby, A.L., Ling, G.V., Schiffman, P.S. and Johnson, D.L. 1996. Ultrastructure and selected struvite containing urinary calculi from dogs. *Am. J. Vet. Res.* 57: 1274-1287

Newton, J.D., Smeak, D.D. 1996. Simple continuous closure of canine scrotal urethrostomy: Results in 20 cases. *J. Am. Anim. Hosp. Assoc.* 32: 531-534

OmPrakash, Singh, K.I. and Sobti, V.K. 1999. Clinical and radiological observations on unsutured and sutured urethrotomy wounds in calves – An experimental study. *Indian J. Vet. Surg.* 20: 35-36

Osborne, C.A., Abdullahi, S., Klausner, J.S., Johnston, G.R. and Polzin, D.J. 1983. Non surgical removal of uroliths from the urethra of female dogs. *J. Am. Vet. Med. Assoc.* 182: 47-50

Osborne, C.A., Clinton, C.W., Bamman, L.K., Moran, H.C., Coston, B.R. and Frost, A.P. 1986. Prevalence of canine uroliths : Minnesota urolith center. *Vet. Clin. Am. Small Anim. Pract.* 16: 27-44

Osborne, C.A., Hammer, R.F. and Klausner, J.S. 1981a. Canine silica urolithiasis. *J. Am. Vet. Med. Assoc.* 178: 809-813

Osborne, C.A., Klausner, J.S., Krawiec, D.R. and Griffith, D.P. 1981b. Canine struvite urolithiasis : problems and their dissolution. *J. Am. Vet. Med. Assoc.* 179: 239-244

Osborne, C.A., Lulich, J.P., and Unger, L.K. 1992. Canine and feline Urolithiasis: Relationship of etiopathogenesis to treatment and prevention. Bojrab M.J, ed. Disease mechanisms in small animal surgery Philadelphia: Lea & Febiger, pp. 464-511

Osborne, C.A., Lulich, J.P., Bartges, J.W. and Felice, L.J. 1990. Medical dissolution and prevention of canine and feline urolith: Diagnostic and therapeutic caveats. *Vet. Rec.* 127: 369-373

Osborne, C.A., Polzin, D.J., Feeney, D.A. and Caywood, D.D. 1985. The urinary system: Pathophysiology, Diagnosis, Treatment: *General Small Animal Surgery*. (Eds. Gourley, I.M., Vasseur, P.B.) Philadelphia pp. 479-658

Osborne, C.A., Polzin, D.J., Johnston, G.R., O'Brien, T.D. 1989a. Internal Medical Disorders of the dog and cat. *Text Book of Veterinary Internal Medicine.* Third edition. Vol 2. (Eds. Ettinger, S.J., Fedman, E.C.) Philadelphia, W.B. Saunders. pp. 2083-2094

Osborne, C.A., Sanna, J.J., Unger, L.K., Clinton, C.W. and Davenport. 1989b. Analysing the mineral composition of urolith from dogs, cats, horses, cattle, sheep, goats and pigs. *Vet. Med.* 22: 750-764

Patil, S.N., Marudwar, S.S., Dhakate, M.S. and Sharma, A.K. 1992. Urethral calculosis in a Doberman dog. *Indian Vet. J.* 69: 1144

Penninck, D.G. 1998. Ultrasonography. *Vet. Clin. North Am. Small Anim. Pract.* 28: 725-1048

Quinn, P.J., Markey, B.K., Carter, M.E., Donnelly, W.J.C., Leonard, F.C. and D. Maguire. 2002. *Veterinary Microbiology and Microbial Diseases*. Third edition. Iowa State University Press, USA, 494 p.

Raila, J., Forterre, S. and Schweigert, F.J. 2003. Lack of retinol and retinyl esters in plasma and urine of dogs with urolithiasis. *J. Vet. Med.* 50: 380-382

Ranganath, L., Jayagopala, N.R. and Umesh, K.G. 1992. An unusual case of cystolith in a bitch. *Indian Vet. J.* 69: 550-551

Rawlings, C.A., Mahaffey, M.B., Barsanti, J.A. and Canalis, C. 2003. Use of laparoscopic assisted cystoscopy for removal of urinary calculi in dogs. *J. Am. Vet. Med. Assoc.* 222: 759-761

Rodgers, A.L., Mezzabotta, M., Mulder, K.J. and Nassimbeni, L.R. 1981. Application of several physical techniques in the total analysis of a canine urinary calculus. *J. South African Vet. Assoc.* 52: 139-142

Saini, N.S., Bansal, P.S., Sobti, V.K., Anand, A.K., Mahajan, S.K. and Bishnoi, P. 2000. Surgical management of multiple urethral and urinary bladder calculi in two male dogs. *Indian J. Vet. Surg.* 21: 100-101

Sastry, G.A. and Rao, R.P. 2001. *Veterinary Pathology.* Seventh edition. CBS Publishers, New Delhi, 779 p.

Schaer, M. 1995. Hyperkalemia and hypernatremia in *Text book of Veterinary Internal Medicine.* Fourth edition. (eds. S.J. Ettinger, E.C., Feldman, eds.) W.B. Saunders, Philadelphia, pp. 47-52

*Schepper, J.D. and Stock, J.V. 1980. Incidence and distribution pattern of canine urinary calculi in Belgium. *Vlaams – Diergeneeskundig.* 49: 178-186

*Senior, D.F. and Kelly, N.C. 1996. Urolithiasis – a nutritional perspective. Manual of companion animal nutrition and feeding, 188 p.

Sharma, C.K., Singh, T. and Palecha, S. 2001. Canine obstructive urolithiasis – A clinical report. *Vet. Pract.* 2: 153-154

Singh, B. and Mirakhur, K.K. 1993. Retrograde migration of urethral catheter: A rare sequele. *Indian J. Vet. Surg.* 14: 102

Singh, V., Tiwari, A., Tiwari, G.P. and Gupta, R.S. 2001. Urolithiasis in dog: A case report. *Intas Polivet* 2: 71-73

Snedecor, G.W. and Cochran, W.G. 1994. *Statistical Methods*. Eighth edition. Iowa State University Press, Ames, Iowa, p. 564

Stevenson, A.E. and Markwell, P.J. 2001. Comparison of urine composition of healthy Labrador Retrievers and Miniature Schnauzers. *Am. J. Vet. Res.* 62: 1782-1786

Thilagar, S., Balasubramanian, N.N. and Archibald. 1996. A retrospective study of urinary obstruction in dogs – A radiographic study. *Indian Vet. J.* 73: 1183-1184

*Voros, K., Felkai, C., Vrabely, T., Papp, T., Horvath, L. 1992. Ultrasonic diagnosis of urinary tract disorders in dogs and cats. *Wiener Tierarztliche Monatsschrift.* 79: 20-29

Waldron, D.R., Heidhund, C.S., Tangner, C.H., Watters, J., Turk, J. and Cox, H.U.1985. The canine urethra. A comparison of first and second intention healing. *Vet. Surg.*14: 213-217

Wallerstrom, B.I. and Wagberg, T.I. 1992. Canine urolithiasis in Sweden and Norway: retrospective survey of prevalence and epidemiology. *J. Small Anim. Pract.* 33: 534-539

Weaver, A.D. 1970. Canine urolithiasis: incidence, chemical composition and outcome of 100 cases. *J. Small Anim. Pract.* 11: 93-107

Weaver, A.D., Pillinger, R. 1975. Relationship of bacterial infection in urine and calculi to canine urolithiasis. *Vet. Record* 97:48-90

Weichselbaum, C.R., Feeney, D.A., Jessen, C.R., Osborne, C.A., Kochler, L. and Ulrich, L. 1998. Evaluation of morphologic characteristics and prevalence of canine urocystoliths from a regional urolith center. *Am. J. Vet. Res.* 59: 379-387

*Wenkel, R., Berg, W. and Prange, H. 1998. Urinary calculi in small animals and other animal species : A retrospective study for 1980-1989. *Deutsche-Tierarztliche-Wochenschrift.* 105: 182-186

*Zentek, J., Mayer, H. and Behnsen, K. 1995. Influence of food composition on the urine pH in the dog. *Kleintierpraxis* 40: 1-18

* Originals not consulted.

# EVALUATION AND MANAGEMENT OF UROLITHIASIS IN DOGS

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# ABSTRACT

Ten clinical cases of canine urolithiasis were studied for age, breed and sex incidence, clinical signs, radiological evaluation, site of obstruction, effect of surgery and its complications, urine analysis, urolith composition and recurrence.

The mean age of incidence was found to be 6.3 years. Incidence was more in German Shepherd Dog followed by Pomeranian and Labrador. There were nine males and one female in the study. Urethral obstruction was seen in all cases including one female.

Out of ten animals one animal (D8) was dull and weak in appearance and all others were active. Difficulty in urination was reported in all the animals. Haematuria was present in five animals (D3, D5, D6, D7 and D10). Moderate abdominal distention was noticed in nine animals. Palpation of the abdomen revealed distended urinary bladder in all animals except in one animal (D8), where bladder could not be palpated and fluid thrill was felt on abdominal palpation indicating rupture of urinary bladder.

Radiographic study revealed that the most common site of obstruction was in the groove of the os penis.

The ten clinical cases of urolithiasis were subjected to fourteen operations viz., nine urethrotomy, two urethrotomy and cystotomy (four operations) and one cystotomy. The study revealed that relieving obstruction by surgical correction was effective, as it ensures immediate relief of obstruction and stress. Urethrotomy was found to be satisfactory in removing urethral calculi in males and compression and flushing of bladder enabled to remove small cystic calculi through the urethrotomy

incision. Cystotomy was required to remove large cystic calculi. The surgical intervention adopted was found effective in relieving obstruction.

The pH of the urine collected during surgery ranged from 6.5 to 8, colour varied from straw coloured to dark red. Consistency of the urine was turbid in all the animals.

On microscopical examination of urine, sediments were present in all the animals. In one dog (D5) crystals were present and identified as triple phosphate and oxalate.

In all animals urine samples showed growth of the microorganisms were more sensitive to ciprofloxacin followed by ampicillin and amoxycillin.

Catheter tolerance was poor in all the animals. Catheter was found removed on the same day itself by all the animals.

Healing of the surgical wound by granulation was good except in two animals, where swelling and oedema of the scrotal sac was seen ( D1 and D8) which were subjected to post scrotal urethrotomy. In all these animals swelling subsided and healing was completed by 30th post operative day.

Bleeding was noticed during and after completion of the surgery in two dogs D4 and D7. In dog D7, injury to cavernosus tissue during the removal of calculi was the cause and was controlled by suturing. In animal D4, bleeding was controlled by administering ethamsylate 1 ml intramuscular for two days.

Recurrence was observed in two cases (20%). In these cases numerous cystic calculi were present when it was originally presented for treatment which might be due to migration of cystic calculi.

The haematological examination showed low haemoglobin content, erythrocyte count, volume of packed red cell in all cases before surgery which increased significantly and reached towards normal by 30th post operative day. There was leucocytosis with shift to left and increase in erythrocyte sedimentation rate which decreased significantly and were normal by 30th post operative day.

The biochemical examination showed elevated blood urea nitrogen, serum creatinine, phosphorus, serum calcium and potassium levels in all the cases before surgery and lowered significantly by 30th day. The fall in serum sodium level seen before surgery showed rise by 30th day and attained near normal value.

Composition of the urolith were analysed by Atomic Absorption Spectroscopy, calcium formed the major component of the calculi followed by phosphorus and magnesium.

Histopathological study of the urinary bladder revealed inflammation and haemorrhage in the submucosa indicating chronic irritation and injury produced by the calculi to the bladder wall.

Electron microscopic study of one of the calculi (D9) was conducted which revealed deposition of concretions around the nidus in concentric rings of varying density and the outer surface showed porosity of varying diameter.