CLINICAL, RADIOGRAPHIC AND PATHOLOGICAL FEATURES OF URINARY CONDITIONS IN DOGS IN NAIROBI, KENYA

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN CLINICAL STUDIES

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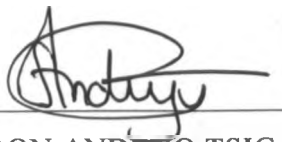
DECLARATION

This thesis is my original work and has not been presented for a degree in any other University.

SIGNED 

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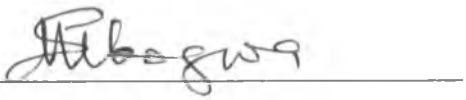
SIGNED 

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This work is dedicated to my parents Mr. and Mrs. Solomon Tsigadi and to Stephen for their encouragement and unwavering support.

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LIST OF ACRONYMS

A:G	Albumin Globulin Ratio
ALT	Alanine Aminotransferase
ALP	Alkaline Phosphatase
ARF	Acute Renal Failure
BUN	Blood Urea Nitrogen
CAT	Clot Activator
CRF	Chronic Renal Failure
CT	Collecting duct
DCT	Distal convoluted tubules
ECF	Extra cellular fluid
EDTA	Ethylene diamine tetra-acetic acid
fl	Femtoliters
GBM	Glomerular basement membrane
GFR	Glomerular filtration rate
Hb	Hemoglobin
H & E	Hematoxylin and eosin
IM	Intramuscular
IVP	Intravenous pyelography
IV	Intravenous
MCHC	Mean corpuscular hemoglobin concentration
MCV	Mean corpuscular volume
LH	Loop of Henle

LUT	Lower urinary tract
PCT	Proximal convoluted tubule
PCV	Packed cell volume
RBC	Red blood cell
USG	Urine specific gravity
VD	Ventrodorsal
WBC	White blood cell

ABSTRACT

This study aimed at evaluating the clinical, radiographic and pathological features of conditions affecting the urinary system of dogs in Nairobi, Kenya. Evaluation of the prostate gland in male dogs, though a reproductive organ, was included in this study due to the fact that the urethra passes through this gland. The retrospective study involved analysis of clinical, postmortem, and histopathology records (1980-2005) from the Department of Clinical Studies and the Department of Pathology, Microbiology and Parasitology, University of Nairobi. The prospective study involved evaluation of dogs brought to the Small Animal Clinic with a complaint related to the urinary system and those that were brought in for euthanasia. Two hundred and fifty four dogs were recruited for the retrospective study of which 66.5% were males while 33.5 % were females. The German Shepherd Dog (39 %) and the cross breeds (33 %) were the most represented. In the retrospective study, nephritis was the most commonly diagnosed condition at post mortem; accounting for 78.3% of the cases with interstitial nephritis being the most common form of nephritis. Other conditions identified were tumors (6.2 %), cystitis (4.8%), hydronephrosis (3.3%), rupture of the urinary bladder (2.4%), renal cysts (1.7%), enlarged prostate (1.4%), prostatitis (1.4 %) and renal abscesses (1.0%). The prospective study involved complete physical examination, collection of blood for hematology and biochemistry, collection of urine for urinalysis, survey and contrast radiography. Post mortem examination of all cases was carried out and samples for histopathology taken. Thirty cases were recruited; with males accounting for 63.3 % and females 36.7 %. The German Shepherd dog was the most represented breed (58 %) followed by the cross breeds (33%). The most frequently observed clinical signs were; wasting (40 %), enlarged prostate (26.7 %) and pale mucus membranes (23.3 %). Less frequently observed findings were urinary incontinence (13.3 %), halitosis (10 %), excessive shedding of the hair coat

(10 %), dehydration (6.7 %) and oral ulcers (6.7 %). Three samples of urine (10 %) had a urine specific gravity in the hyposthenuria range while two samples (6.7 %) were in the isothenuria range. Urine sediment was observed in 7 cases (23.3 %), high levels of bilirubin were observed in 7 cases (23.3 %) and blood was seen in 5 of the cases (16.7 %). Hematology and biochemistry results were largely unremarkable; this was attributed to the reserve capacity of the kidneys that enables normal function to continue even with as few as 25% of its original nephrons. Survey and contrast radiography using Iopamidol® was performed on all the cases under either deep sedation or general anesthesia. The radiographs were obtained with 70-75 kV, 16-20 mAs and a focal length of 100 cm. The nephrogram and concurrently the pyelogram was poor in 23.3 % of the cases, fair in 33.3 % of the cases, good in 40 % of the cases and absent in 3.3 % of the cases. Other findings on contrast radiography were; dilated renal pelvis (10 %), shrunken kidneys (33.3 %), enlarged kidneys (20 %), thickened urinary bladder wall (6.7 %). The most frequent pathological changes included scaring and pitting of the renal surface (26.7 %), adherent renal capsule (26.7 %), urates in the bladder (23.3 %), enlarged prostate (23.3 %), thickened bladder wall (16.7 %), pale kidneys (16.7 %) and renal cysts (13.3 %). The study provides baseline data for further clinical research in canines in other parts of the country to determine the epidemiological patterns of these conditions at national level. Contrast radiography proved to be a useful aid to diagnosis and should be used more frequently as a tool for confirmatory diagnosis. The findings would be useful for dissemination to undergraduate and postgraduate studies as well as continuing professional development for small animal practitioners.

CHAPTER ONE

1.0 INTRODUCTION, HYPOTHESIS, JUSTIFICATION AND OBJECTIVES

1.1 INTRODUCTION

The urinary system comprises of paired kidneys, paired ureters, a urinary bladder and a urethra. Renal diseases, whether immune-mediated, neoplastic, degenerative, or due to infection, cause death and debility and manifest varied clinical signs that range from anorexia to anuria. Renal disease accounts for as much as five percent of all deaths in dogs (Pollen, 2001). The disease may affect glomeruli, tubules, interstitial tissues, and/or blood vessels.

Clinical assessment of early renal dysfunction often presents a challenge in small animal practice. In affected dogs, the kidneys are unable to concentrate urine when approximately 66% of nephrons function is lost, and renal failure occurs when greater than 75% of nephrons are nonfunctional (Kerl and Cook, 2005).

Great advances have been made in canine nephrology and urology worldwide. The availability of techniques that facilitate early and accurate diagnosis of renal conditions has presently improved the quality of management of the renal patient and afforded better prognosis of affected dogs. The global picture notwithstanding, information on the clinical, radiological, pathological and laboratory profiles of renal conditions occurring in dogs in Kenya is scanty. Despite the advances in veterinary urology globally, the prognosis for the renal patient in Kenya is grave, and more often than not the animal

usually dies soon after diagnosis often due to delayed diagnosis, misdiagnosis or poor management.

A preliminary review of medical and postmortem records available at the University of Nairobi Small Animal Clinic and at the Department of Pathology, Microbiology, and Parasitology respectively (2004 to 2005), revealed that a total of 45 dogs had been diagnosed with conditions affecting the urinary system. Apart from cystitis that was more specifically identified, most of the conditions were generally diagnosed as renal failure. The diagnoses did not reflect exactly which part of the urinary system was affected. Therefore, further investigation of conditions of the urinary system in dogs in Kenya was required to determine their incidence, etiology and to support the management of such conditions. Information on the clinical, radiographic, pathologic and laboratory features of conditions affecting the urinary system would greatly improve the diagnostic and prognostic skills of clinicians and assist in determination of appropriate clinical and surgical management protocols of affected dogs. This study aimed to record the various urinary conditions of dogs in Nairobi, based on the clinical signs, laboratory data and pathological features.

1.2 HYPOTHESIS

Urinary system conditions in Nairobi area go undiagnosed due to unavailability of diagnostic aids and the high cost associated with diagnostic tests.

1.3 JUSTIFICATION

This study was justified by the fact that a review of records available at the Small Animal Clinic and the Department of Pathology, Parasitology and Microbiology, University of Nairobi revealed that majority of the cases went undiagnosed at the clinical level only to be discovered at postmortem.

1.4 OBJECTIVES

The objectives of the study were;

1. To determine the conditions affecting the urinary system in dogs in the Nairobi area, Kenya.
2. To evaluate clinical, hematological and biochemical features of urinary conditions in dogs in Nairobi area, Kenya.
3. To evaluate the radiographic and pathologic features of urinary conditions of dogs in Nairobi, Kenya.

CHAPTER TWO

2.0 LITERATURE REVIEW

In mammals, the kidneys function as major excretory organs for elimination of metabolic wastes from the body in the form of urine. The kidneys are also involved in the conservation of essential metabolites (ions, sugars, amino acids and water) and therefore participate in maintenance of an optimal internal environment. The lower urinary tract (bladder and urethra) is a specialized organ system devoted to the storage and periodic release of urine while the ureters form the upper urinary tract and act as transport conduits for urine from the kidneys (Banks 1993; DiBartola, 1995; Finco 1997). Symptoms associated with dysfunction of the urinary system include lethargy, anorexia, mucosal ulcers, vomiting, diarrhoea, weight loss, anemia and altered urine output. These signs are generally referred to as renal failure, uremia, or uremic syndrome and they reflect the development of abnormalities in many tissues secondary to renal dysfunction (Finco, 1997).

2.1.0 THE KIDNEYS

Kidneys are paired and retroperitoneal organs that receive 25 percent of the cardiac output. They provide life-sustaining functions that include: Maintenance of fluid volume, pH and composition; regulation of blood pressure (via renin angiotensin system) erythrocyte production (via erythropoietin); and conversion of vitamin D into its active form, 1-25-dihydroxycholecalciferol. Kidneys filter the entire blood volume nearly twice every hour and limit urine production to approximately 0.001 percent of the blood filtered. Hence, for every liter of blood flowing through the kidney of a healthy animal,

approximately 1-2 milliliters of urine is produced (Banks, 1993; DiBartola, 1995; Pollen, 2001).

Renal functions are sums of the activities of thousands of nephrons, the functional units of the kidneys. Each nephron has two divisions, the renal corpuscle that comprises of the glomerulus (G) and the glomerular/Bowmans capsule and the renal tubule that comprises of the proximal convoluted tubule (PCT), loop of Henle (LH), distal tubule (DT) and the collecting duct (CT). The number of nephrons varies between species; the dog has about 430 000 nephrons per kidney. In the different dog breeds, nephron size rather than nephron number varies with body size (Finco, 1997). The anatomical divisions of the nephrons have different functions that result in the end product, urine (Banks, 1993).

The nephrons are susceptible to damage due to many causes such as poisons, aging, infection, trauma, cancer, autoimmune diseases, and genetic predisposition. If any of these occur, the entire nephron stops functioning. Fortunately, due to the reserve capacity of the kidney and the ability of the nephrons to grow larger, the kidney can still function. If damage to nephrons occurs gradually and the surviving nephrons have enough time to hypertrophy, a kidney can continue to function with as few as 25 percent of its original nephrons. When the number of functioning nephrons drops below 25 percent or when damage occurs too suddenly for the remaining nephrons to compensate, kidney failure occurs (Finco, 1997).

2. I.1 FORMATION OF URINE

Filtration does not occur before the blood enters the glomerular capsule on account of the non-porous nature of the endothelial cells that line the afferent glomerular arteriole. The endothelium of the glomerular capillaries, however, has numerous minute pores, or fenestrae, through which elements of the blood, such as leukocytes, platelets, and erythrocytes, cannot pass (Henrikson, 1998). Blood pressure forces fluid from the capillaries through the fenestrae (Campbell, 1990). The fenestrae are relatively large and therefore do not act as a major barrier to plasma proteins or the molecules bound to them (Guyton and Hall, 1998).

The endothelial lining of the glomerular capillaries and mesangial matrix, provide structural support for the glomerulus. Together, they make up the first of three layers that compose the filtration barrier of the glomerular capsule. The glomerular basement membrane (GBM) separates the innermost endothelial and mesangial cells from the outermost layer of the barrier, the podocytes. Podocytes are so named because each cell body has elongated processes that wrap around the capillary (Henrikson, 1998).

Large amounts of water and small solutes pass effectively through the GBM, but passage of plasma proteins is prevented, due largely to the membrane's composition. The lamina interna and the lamina externa make up the inner and outer layers of the GBM, respectively. The lamina interna acts as a filter for macromolecules of a particular size, i.e. those that are too large do not filter. The lamina externa mainly aids the function of the middle layer, or lamina densa, of the GBM. These layers are principally composed of

type IV collagen, laminin, and fibronectin and have a slight negative charge (Banks, 1993; Henrikson, 1998; Pollen 2001,). The electron dense lamina densa allows filtration of macromolecules of a particular charge. The negative charge repels anionic molecules in the plasma, in effect preventing them from crossing the barrier. The type IV collagen concentration in the lamina densa, as well as proteoglycans that compose the lamina interna and externa create this charge. In addition to providing structural support and engulfing this filtrate, mesangial cells are also believed to aid in the control and passage of blood through the glomerular capillaries by the production of vasoactive agents (Henrikson, 1998).

The outermost layer of the filtration barrier of the glomerular capsule is composed of visceral epithelial cells called podocytes. The "foot processes," or pedicles, lie adjacent to one another around the capillary. The narrow spaces, termed slit pores or filtration slits, between pedicles allow for further filtration (Henrikson, 1998).

Normally, very little protein is present in the urine as a result of anionic proteins being repelled by the negatively charged lamina densa (Barsanti and Finco, 1979). The passage of neutral macromolecules is inhibited by the size barrier of smaller slit pores on the outermost layer of the GBM (Guyton and Hall, 1998). As proteins decrease in size, they are filtered in increasing amounts. This size barrier approaches that of albumin, the smallest of proteins (Bergstein 1999). The proteins in the filtrate are mainly reabsorbed in the PCT and are hydrolyzed by lysosomal enzymes (Gassee and Verniory, 1977). Charge depletion may contribute to proteinuria by altering the size-selective properties of the

GBM. Proteins that appear in the urine then, have not been reabsorbed by the PCT. In a pathological state, the presence of proteins may indicate pathology in the tubules, the glomerulus, or both—in which case large and small proteins are excreted (Lillehoj and Poulik, 1986).

2.1.2 RENAL DISEASE

Renal disease is defined as the occurrence of morphologic or biochemical renal lesions of any size or severity in one or both kidneys. Most renal lesions arise as a result of injury to or deterioration of one or more of the four major components of normal kidneys (vessels, glomeruli, tubules, and interstitium), but some renal lesions are the result of defective renal development (Duncan *et al,* 1994; Pollen, 2001; Lees, 2004).

Renal disease (**Appendix 1**) accounts for as much as five percent of all deaths in dogs globally (Pollen, 2001). Signs of renal disease include; fever, cachexia, anorexia, halitosis, oral ulceration, nausea, vomiting, diarrhoea or constipation, anaemia, edema, nocturia, oliguria, anuria, polyuria and polydypsia, flank pain, hypertension, abdominal distention, acute respiratory distress or acute blindness secondary to hypertension. Sometimes signs of renal disease may not be accompanied by clinical evidence of loss of function (DiBartola, 1995; Finco, 1997; Kerl and Cook, 2005).

The reduction of glomerular filtration rate (GFR) by renal disease leads to inability of the kidneys to maintain normal extracellular fluid (ECF) composition, and when this occurs, concentration of nitrogenous wastes (e.g., urea, creatinine) increase to abnormal

concentrations in the ECF. Therefore, existence of renal failure can be defined by the presence of azotemia that is caused by renal disease. Thus, renal failure is said to occur when there are clinical signs or laboratory abnormalities that are caused by reduced kidney function (Pollen, 2001). Renal failure is commonly distinguished as either acute renal failure (ARF) or chronic renal failure (CRF) based on four criteria: history, physical examination, laboratory tests, and prognosis. Acute renal failue is defined as primary renal dysfunction of sudden onset that is potentially reversible, while CRF is often the result of slow insidious destruction of renal parenchyma and is irreversible (Finco, 1997).

Clinical assessment of early renal dysfunction presents a diagnostic challenge to many practitioners; it is often not easy to detect the presence of ongoing renal disease in the veterinary patient. A definitive diagnosis is usually made when the conditions have advanced near their end stages and have caused the affected animals to develop a degree of renal failure that is sufficient to be manifested by clinical signs of uremia (Lees, 2004; Kerl and Cook, 2005).

2.1.3 DIAGNOSIS OF RENAL DISEASE

The objective of an accurate diagnosis of renal disease and renal failure in dogs is to enable timely application of therapeutic interventions that may slow or halt disease progression. Physical examination and laboratory tests including hematology, biochemistry, urinalysis and diagnostic imaging are used in the diagnosis of renal disease (Lees, 2004).

Blood urea nitrogen and serum creatinine concentrations are most frequently analysed as indirect measures of glomerular filtration rate in human and veterinary medicine (Braun *et al,* 2003; Cortadellas *et al*, 2008).

A critical review of methods and applications of fractional extraction test in domestic animals has been published (Lefebvre *et al.,* 2008). More recently, urinary markers that are more sensitive indicators of renal injury and have the potential to reflect the site and severity of damage have been described (Price, 2002; Gamer and Wiedmeyer, 2007; Nakamura *et a.,l* 2008; Murgier *et al.,* 2009; Smets *et al.,* 2010). However, most of these tests are currently not readily available to veterinary practitioners in developing countries.

Although renal biopsy is a relatively safe procedure that has low frequency of severe complications (Vanden *et al,* 2005), its clinical application by small animal practitioners in developing countries is limited by cost and availability of the technology. Light and electron microscopy has been used in the evaluation of renal pathology in small animals (Scaglione *et al.,* 2008).

2.1.3.1 PHYSICAL EXAMINATION

The body condition of the dog, colour of the mucous membranes, and the level of hydration may suggest the presence of renal disease. Abnormal renal size, shape, or firmness may be detected by palpation during physical examination (DiBartola, 1995).

2.1.3.2 URINALYSIS

Complete urinalysis, including examination of urine sediment, is a key element in the clinical investigation of illness in all dogs that may have renal disease (Duncan *et al.*, 1994, DiBartola, 1995; Lees, 2004,).

Urinalysis assessment includes evaluation of physical characteristics (color, clarity, and volume), biochemical parameters (urine pH, urine specific gravity, blood, glucose, ketones, bilirubin, urobilinogen and protein) and microscopic sediment evaluation (red blood cells (RBC), white blood cells (WBC), micro-organisms, epithelial cells, crystals and casts). Many of these parameters are influenced by the method used to collect the urine sample as well as the method of sample processing and examination and this should be considered during interpretation of urinalysis results. The urine sample may be obtained via catheterization, cystocentesis or when the dog is urinating (free catch urine sampling). In both cystocentesis and urinary catheterization, there is a risk of iatrogenic hematuria. The values obtained in urinalysis are compared to the normal reference ranges for dogs (Reine and Langston, 2005).

2.1.3.3 RADIOGRAPHY

Survey Radiographic Evaluation

Survey radiographs mainly provide a morphologic evaluation of kidney size, shape, and density. In addition, it is also possible to assess any abnormal opacity near the kidneys such as air and minerals. Survey radiographs may not provide adequate morphologic

information when the patient is emaciated or has increased volume of peritoneal or retroperitoneal fluid (DiBartola, 1995; Feeney and Johnston, 2002).

The right lateral view is the view of choice for survey renal radiography since it permits greater longitudinal separation of the radiographic images of the left and right kidneys (Feeney & Johnston, 2002).

Contrast Radiographic Evaluation (excretory urography/ intravenous urography/ intravenous pyelography)

This procedure evaluates the anatomic structures and assesses the qualitative excretory function and the structure of the entire upper urinary tract (both kidneys and ureters). It is used to verify and localize upper urinary tract disease and it may be used to assess the reversibility of renal disease (Feeney and Johnston, 2002; Heuter, 2005).

Contrast radiography may be used in both azotemic and non-azotemic patients, provided that hydration is adequate. Adequate patient hydration is essential when performing this procedure to assure proper renal perfusion, and hence glomerular filtration and renal concentrating ability (Feeney and Johnston, 2002; Bradley, 2003; Heuter, 2005). The procedure is performed under general anesthesia, with fluid therapy being administered if clinically indicated. Food is withheld for 24 hours and a cleansing enema administered 2 hours before radiography (Feeney and Johnston, 2002). Sterile, water-soluble ionic or nonionic iodinated contrast medium is used at a dose of 400mg iodine per pound of body weight injected via a pre-placed intravenous catheter (Feeney and Johnston, 2002). Catheter placement should be maintained for at least 15 to 20 minutes after

administration of the contrast medium because it provides a readily accessible route in the event of an adverse reaction to the contrast medium. A typical study requires right lateral and ventro-dorsal radiographs to be taken at 5-20 seconds, 5, 20, and 40 minutes after administration of the contrast medium (Feeney and Johnston, 2002; Bradley, 2003; Heuter, 2005).

Excretory urogram consists of nephrographic and pyelographic phases. The nephrogram is seen as the opacification of the functional renal parenchyma, whereas the pyelogram is the opacification of the renal pelvis, pelvic recesses, and ureters. Each phase is evaluated separately, and the sequence of these phases is compared with the normal findings (Feeney and Johnston, 2002; Heuter, 2005).

In rare circumstances, the injection of contrast media may result in renal shutdown (contrast-induced renal failure) (Heuter, 2005). This may be recognized by the failure of the pyelogram phase to appear when expected, since no contrast will be excreted. When this occurs, fluid therapy and diuresis should be instituted immediately and the situation is usually reversible. Other potential side effects of intravenous urography include nausea, vomiting, urticaria, a transitory drop in blood pressure, and very rarely anaphylactic reactions. Many of the minor side effects are overcome by the use of general anesthesia (Bradley, 2003).

2.1.3.4 ULTRASONOGRAPHY

Renal ultrasonography is a noninvasive, safe technique that is now more commonly practiced. Using this method, information on the renal architecture may be provided without the use of contrast medium (Feeney and Johnston, 2002). Despite these advantages, its limitations are that; it is very dependent on the skill of the user, especially with regards to abnormalities of the renal pelvis and ureters. Secondly, whereas ultrasonography may provide more detail regarding the renal parenchyma, the excretory urogram remains a ubiquitous test that gives excellent detail of the entire urinary tract, and is an essential tool for the assessment of the renal pelvis and especially the ureters (Heuter, 2005).

2.2 THE URETERS

The ureters are paired tubular structures that together with the kidneys, form the upper urinary tract; each ureter is less than 2 or 3 mm in diameter at the hilus. They act as transport conduits, transporting urine that collects in the renal pelvis into the urinary bladder (Finco, 1997; Feeney and Johnson, 2002). The ureters are primarily retroperitoneal, but become intraperitoneal as they approach their termination at the bladder trigone (Feeney and Johnson, 2002).

2.2.1 DIAGNOSIS OF URETERAL DISEASE

Primary diseases of the ureters (**Appendix 1**) are uncommon in dogs. When the ureters are involved in disease processes, the kidney, bladder, or urethra are usually involved as well (Heuter, 2005). Thus, the clinical signs of ureteral disease cannot be distinguished

from clinical signs related to concurrent disease of other parts of the urinary tract (DiBartola, 1995). The most useful and accurate method of diagnosis of ureteral disease is excretory urography; normal ureters are not visible on survey radiographs (Feeney and Johnson, 2002).

2.3 THE URINARY BLADDER AND URETHRA

The urinary bladder and urethra form the lower urinary tract (L.U.T), which is devoted to the storage and periodic release of urine. In addition, they preserve fluid and electrolyte balance by maintaining urine composition and protect against pyelonephritis, hydronephrosis and maintain urinary continence (Banks, 1993; Lulich *et al.*, 1995).

The clinical signs of L.U.T disease are dysuria, pollakiuria, stranguria, hematuria and urinary incontinence. The three most common diseases of the L.U.T are cystitis, incontinence and urolithiasis. Diseases of the L.U.T (**Appendix 1**) are usually not associated with systemic illness. However, diseases that concurrently affect both the lower and upper urinary tracts cause systemic illness (Park and Wrigley, 2002; Essman, 2005).

2.3.1 DIAGNOSIS OF LOWER URINARY TRACT DISEASE

Accurate diagnosis requires appropriate integration of the history, physical examination, and laboratory findings. Urinalysis, quantitative culture for bacteria, ultrasonography, and radiography of the complete urinary tract are employed in the diagnosis of L.U.T disease.

Results of hematology and serum chemistry seldom indicate abnormalities of the urinary system, except when disease processes extend beyond the L.U.T (Lulich *et al.*, 1995).

2.3.1.1 SURVEY RADIOGRAPHIC EVALUATION OF URINARY BLADDER

The signs of urinary bladder disease on survey radiographs are limited. Clinical signs that indicate disease of the urinary bladder include poor or nonexistent bladder visualization and abnormal bladder position, shape, thickness, size and opacity (Park and Wrigley, 2002).

2.3.1.2 CONTRAST RADIOGRAPHIC EVALUATION OF THE URINARY BLADDER

Contrast radiography is useful in the evaluation of mucosal irregularities, diverticula, urine leakage, and radioluscent uroliths in the urinary bladder (Lulich *et al.*, 1995). The bladder may be visualized on ventrodorsal and lateral views at 20 and 40 minutes following intravenous pyelography. Retrograde contrast cystography is specific for the diagnosis of bladder conditions and it is easy to perform with relatively few complications. Different types of cystography (positive versus negative contrast) may be used depending on the type of information that the clinician hopes to obtain. Negative contrast media include room air, carbon dioxide, or nitrous oxide while positive contrast media include the different formulations of organic iodine. These agents should be diluted to a 20% solution using sterile water before they are infused into the bladder (Park and Wrigley, 2002; Essman, 2005).

Plain radiographs of the urethra are rarely helpful, although radiopaque urethral calculi maybe seen (Pechman, 2002). In contrast urethrography, water-soluble organic iodide contrast media should be used. A balloon tipped catheter is inserted into the urethra and the balloon inflated to prevent reflux of contrast medium. A 10 to 15 ml volume of contrast medium is usually used in dogs (Pechman, 2002).

2.3.1.3 ULTRASONOGRAPHY OF THE URINARY BLADDER

The fluid filled urinary bladder is readily and easily evaluated by sonography. The superficial location enables high-resolution imaging and the urine provides high sonographic contrast, which results in clear visualization of the bladder wall and intra-luminal abnormalities. Urolithiasis and neoplasia are readily and accurately visualized in sonography (Park and Wrigley, 2002). Ultrasonography permits evaluation of the thickness of the wall of the urethra as well as the mucosal surface (Pechman, 2002).

CHAPTER THREE

3.0 MATERIALS AND METHODS

The study comprised of two parts; a retrospective and prospective component.

3.1 RETROSPECTIVE STUDY

The retrospective study involved analysis of clinical and postmortem records on the basis of breed, age, sex and postmortem (histopathological) diagnosis of respective conditions affecting the urinary system of dogs submitted to the Small Animal Clinic, Department of Clinical Studies, and the Department of Veterinary Pathology, Microbiology and Parasitology, University of Nairobi. The sampling frame included cases from 1980 to 2005. A total of two hundred and fifty four (254) cases were recruited into the study.

3.2 PROSPECTIVE STUDY

Dogs presented to the Small Animal Clinic, Department of Clinical Studies, University of Nairobi for humane disposal (euthanasia) and those presented to the clinic with a complaint referable to the urinary system from January 2006 to January 2007 were recruited for the study. Physical examination, that is, evaluation of body condition, colour of mucus membranes, heart and respiratory rate, body temperature and the size of the prostate gland in males through digital rectal palpation, complemented with urinalysis, hematology, biochemistry, radiography including contrast radiography, postmortem and histopathology examination were performed on the recruited cases. For contrast radiography the dogs were housed in the clinic kennels and starved overnight with free

access to water prior to intravenous pyelography (IVP) being performed. A total of 30 cases were examined in this part of the study.

3.2.1 PHYSICAL EXAMINATION

A record of the age, breed and sex of the patient and clinical background information was taken at the outset. Physical examination involved evaluation of the body condition, colour of the mucus membranes, heart and respiratory rate and body temperature. The size of prostate gland in male dogs was assessed through digital rectal palpation. Deep abdominal palpation was performed to evaluate the size, shape and location of the kidneys and urinary bladder. The type and frequency of clinical signs were recorded for each dog.

3.2.2 URINALYSIS

Urine samples were collected through cystocentesis with the dog in right lateral recumbency. The urine samples were obtained aseptically using a 1.5-inch 21-gauge needle attached to a 10ml syringe and transferred to labeled sterile universal bottles. Samples were routinely examined within 2 hours of collection.

Physical examination of the urine entailed visual evaluation of colour and clarity of the sample. The specific gravity, pH, protein, glucose, ketone, blood, bilirubin, urobilinogen levels in the urine were determined using Combur® dipstick (**Figure 1**) and data was recorded and compared with normal reference values for dogs. Thereafter, low speed centrifugation (1500 revolutions for 5 minutes) was performed to separate sediments. The

supernatant was removed and the sediment suspended in the remaining volume of urine. A drop of this mixture was then placed on a microscope slide, a coverslip applied and examined unstained using a light microscope at X40 objective magnification. The sample was examined for the presence of red blood cells (RBCs), epithelial cells, leucocytes, casts, crystals, bacteria and yeast cells.

A **B**

Figure 1. The reference chart on the container (A) and Urine dipstick strips (B).

3.2.3 HEMATOLOGY AND BIOCHEMISTRY

Blood samples were aseptically collected through venipuncture of the cephalic vein, using a 19 gauge needle and a 10ml syringe and transferred to vacutainer ® k_3 EDTA and CAT vials for hematology and biochemistry, respectively (BD Vacutainer systems, Belliver Industrial Estate, Plymouth UK).

An automated hematology analyzer (MS4 Hematology analyzer, Melet Schloesing Laboratories, 9 Claussen Jules Cesar, 9552 OSNY France) (**Figure 2**) was used to determine packed cell volume (PCV), red blood cell (RBC) count, hemoglobin concentration, total protein, white blood cell (WBC) count and WBC differential count. Blood smears for differential WBC count were stained with Giemsa 1:5 and the counts made using a light microscope at X 1000 and oil immersion. One hundred white blood cells were counted and the percentage of each of the cells (neutrophils, lymphocytes, monocytes, eosinophils and basophils) recorded.

packed cell volume (PCV), creatinine, total protein, albumin (A), globulin (G), A/G ratio, alkaline phosphatase and alanine aminotransferase levels were measured using Biocon® Diagnostik reagents in a spectrophotometer (**Figure 3**).

Figure 2. An automated hematology analyzer

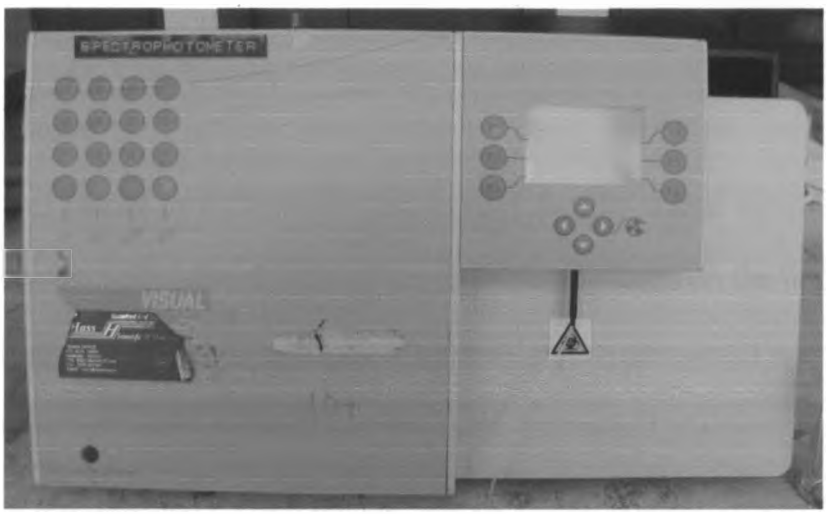


Figure 3. A spectrophotometer

3.2.4 RADIOGRAPHY

A portable X-ray machine (Practix 33 Plus, Version 2, Mobile Radiography System, ©2000 Philips Medical Systems, Roentgenstrasse 24, D-22335 Hamburg, Germany) was used with conventional screen films (XBM, X-RAY RETINA 30x40cm 100NIF, Fotochemische Werke GMBH, Berlin, Germany). Deep sedation of the patient was achieved before radiography by intramuscular administration of xylazine hydrochloride (XYLAZINE 20 inj., KEPRO, HOLLAND) at a dose of 2mg/kg body weight intramuscularly (IM). In cases where sedation with xylazine could not facilitate good restraint, general anaesthesia was induced by intravenous injection (IV) of thiopental Sodium (THIOPENTAL inj., BP 500 ROTEXMEDICA, TRITTAU, GERMANY) at a dose of 10mg/kg body weight. An intravenous catheter (Cathlon IV^{TM}, Jelco Laboratories, Raritan, N.J) was placed in the cephalic vein after shaving and disinfecting with 70% alcohol to facilitate administration of the contrast agent. Both plain and contrast radiographs were obtained with 70-75kV, 16-20mAs and a focal length of 100cm. All the 30 dogs recruited into the prospective study were radiographed

Plain Radiography

The patient was placed in right lateral recumbency for the lateral view and on dorsal recumbency for the ventrodorsal view of the abdomen, centered on the umbilicus. Plain radiographs (right lateral and VD abdomen, centered on the umbilicus) were taken. Plain radiographs were necessary to check that exposure factors and positioning were optimal and that the animal had been adequately prepared, and to identify lesions that could be

obscured by contrast media. Plain radiography also aided in the assessment of kidney location, size and shape.

Contrast radiography

Contrast radiography was used to assess the anatomic structure and the qualitative function of the kidneys and ureters. This was achieved by assessing and recording the opacification of the renal parenchyma (nephrogram) and the renal pelvis, pelvic recesses and the ureters (pyelogram). Thus iodinated contrast media, Iopamidol® 370, 350 or 300 (Bracco Industries, Italy) (**Figure 4**) was administered at a dose of 1mg/kg of body weight via the preplaced cephalic catheter. Ventrodorsal radiographic views of the abdomen, centered on the umbilicus were taken at 5 to 20 seconds, 5 minutes, 20 minutes, and 40 minutes after injection for general assessment. Lateral views of the abdomen were taken with the patient in right lateral recumbency, 5 minutes after injection for general assessment and 40 minutes after injection to observe the urinary bladder (Feeney and Johnson, 2002).

Renal function was qualitatively estimated by evaluating the degree of opacification in the nephrogram and pyelogram, and also by evaluating the opacification and fading patterns of the nephrogram.

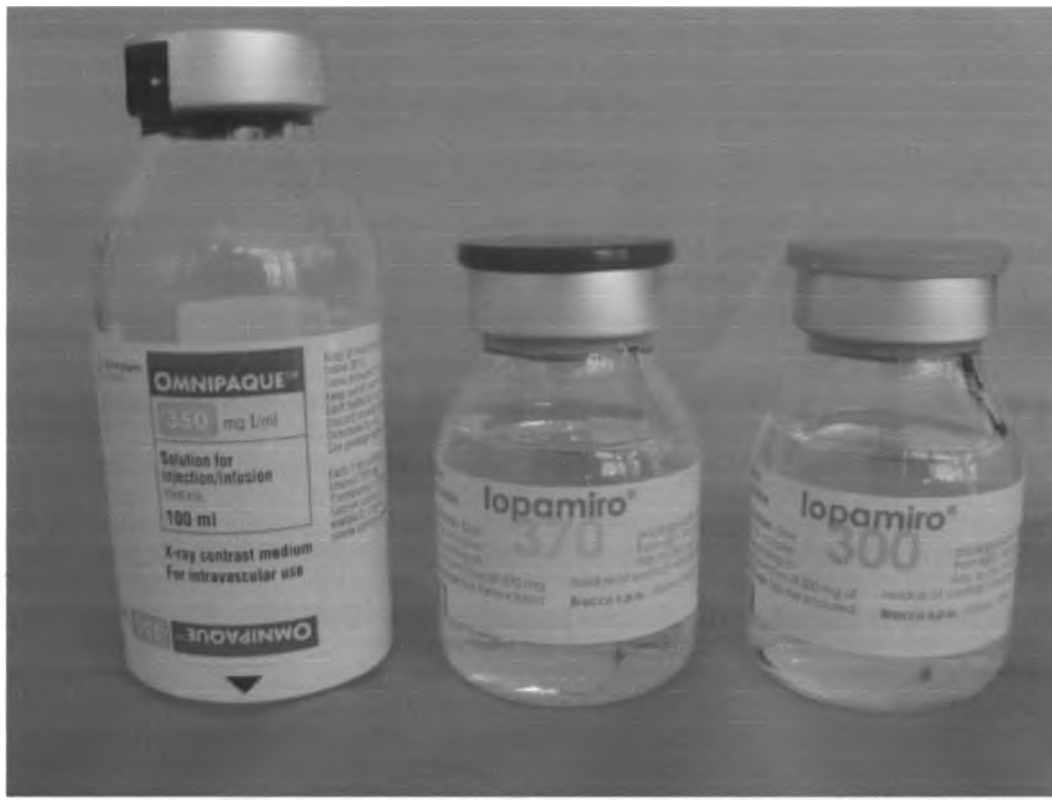


Figure 4. Iodinated contrast media containing 350mg, 370mg and 300mg iodine/ml

3.2.5 GROSS POSTMORTEM EXAMINATION

A standard systematic necropsy (Carlton and McGavin, 1995), was performed on all 30 dogs and observations recorded. From each carcass examined, samples of kidneys, urinary bladder, urethra, ureters and the prostate gland were obtained and fixed in 10% neutral buffered formalin for histopathology.

3.2.6 HISTOPATHOLOGICAL EXAMINATION

The specimens were processed using standard histopathology procedures (Banks, 1993). After 48 hours of formalin fixation, tissues were trimmed, and processed in an automatic tissue processor in which they were dehydrated through immersion in increasing alcohol concentrations until total dehydration was achieved using absolute ethanol. Clearing was the achieved using xylene and finally the processed tissues were embedded in paraffin wax. Paraffin embedded tissues were sectioned at 5µm thickness with a microtome (LEITZ WETZLAR, GERMANY), and stained with hematoxylin and eosin (H&E) using standard protocol for histopathology (Banks, 1993).

CHAPTER FOUR

4.0 RESULTS

The results of the retrospective and prospective studies were separately evaluated and are described below.

4.1 RETROSPECTIVE STUDY FINDINGS

A total of 1 638 case records were reviewed in the retrospective study period, both at the Department of Veterinary Pathology, Microbiology and Parasitology and at the Small Animal Clinic , Department of Clinical Studies and of these 254 were recruited into the study denoting a prevalence of 15.5%. Of the 254 dogs recruited into the retrospective study 169 (66.5%) were male, while 85 (33.5%) were female. The German Shepherd dog (Alsatian) (39%) and the cross-breeds (33%) were the two most represented breeds. Other breeds of dogs included; Doberman (3.1%), Labrador (2.4%), Golden Retriever (2%), Japanese Spitz (1.4%), other terriers (1.2%), Rottweiler (0.8%), Dalmatian (0.8%), Dachshund (0.8%), Jack Russell Terrier (0.8%), Ridgeback (0.4%), Cocker Spaniel (0.4%), Poodle (0.4%) and Bull Terrier (0.4%). The distribution of breeds of dogs diagnosed with conditions affecting the urinary system is presented in **Figure 5**.

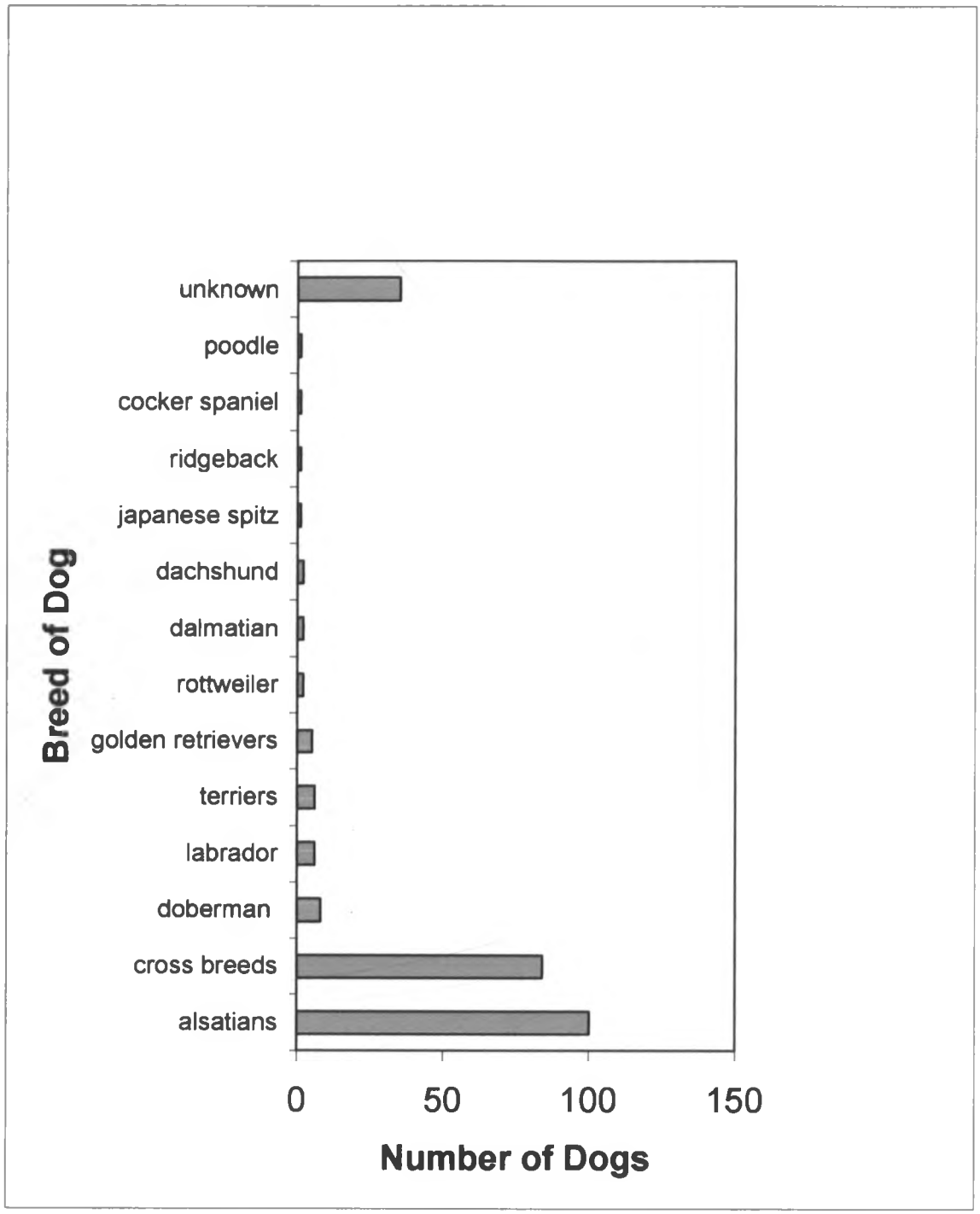


Figure 5. The distribution of breeds of dogs diagnosed with conditions affecting the urinary system

Nephritis was the most frequently diagnosed condition, affecting 199 out of 254 dogs (78.3%) diagnosed with conditions of the urinary system. Three histopathological types of nephritis (interstitial nephritis, glomerulonephritis and pyelonephritis) were identified in 32 (16.1%) of these dogs diagnosed with nephritis. However, histopathological classification was not performed for 167 out of the 199 (83.9%) dogs diagnosed with nephritis. Of the 32 dogs whose samples were histologically examined 16 (50%) had interstitial nephritis, 10 (31.3%) had pyelonephritis, while 6 (18.7%) had glomerulonephritis. Prostatitis and renal abscesses were the least common conditions diagnosed (0.5%). Other less frequently encountered lesions were cystitis, hydronephrosis, tumors, rupture of the urinary bladder, renal cysts and enlarged prostate. The type and frequency of the conditions affecting the urinary system in dogs recruited into the retrospective study is presented in **Figure 6**.

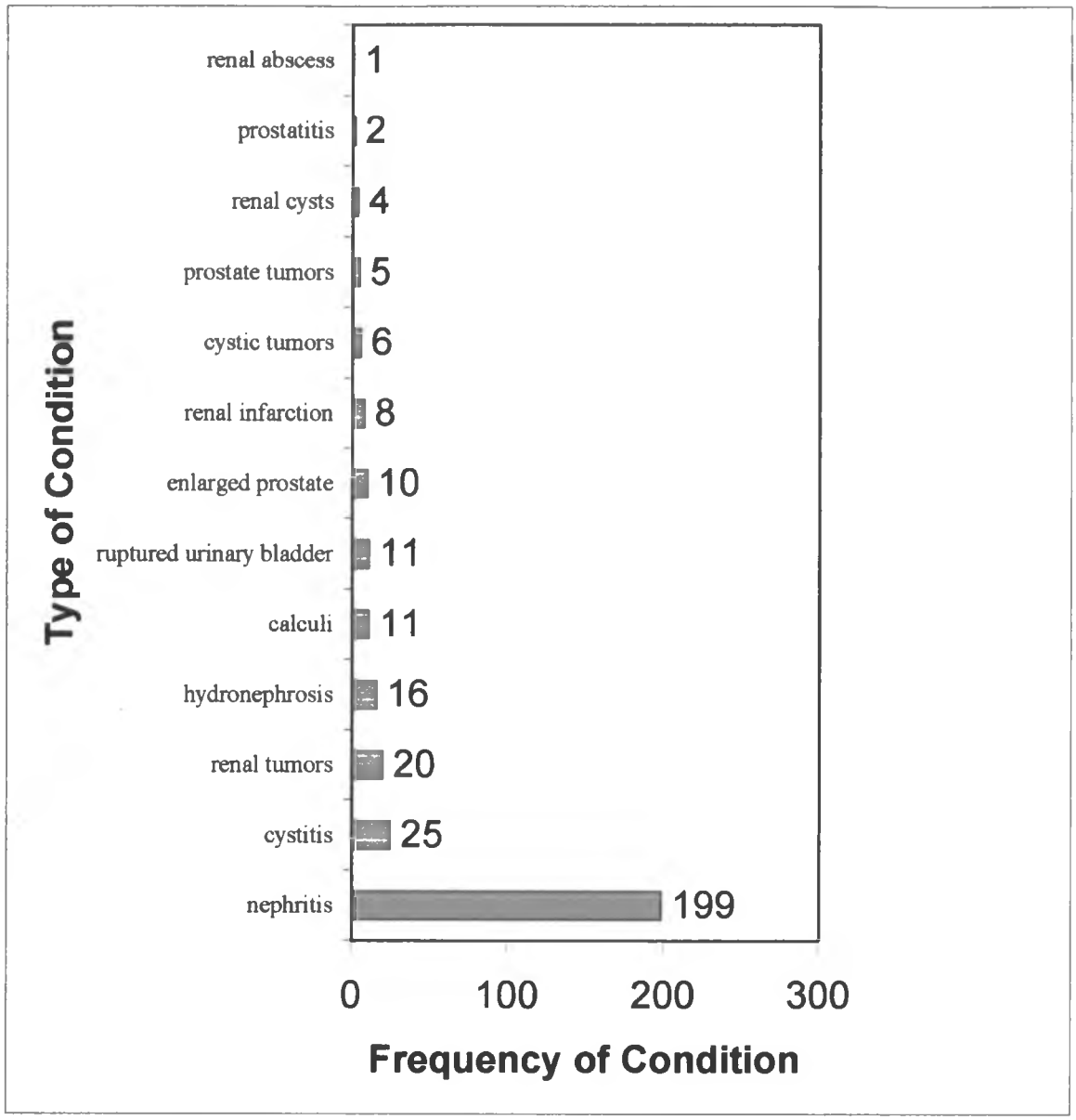
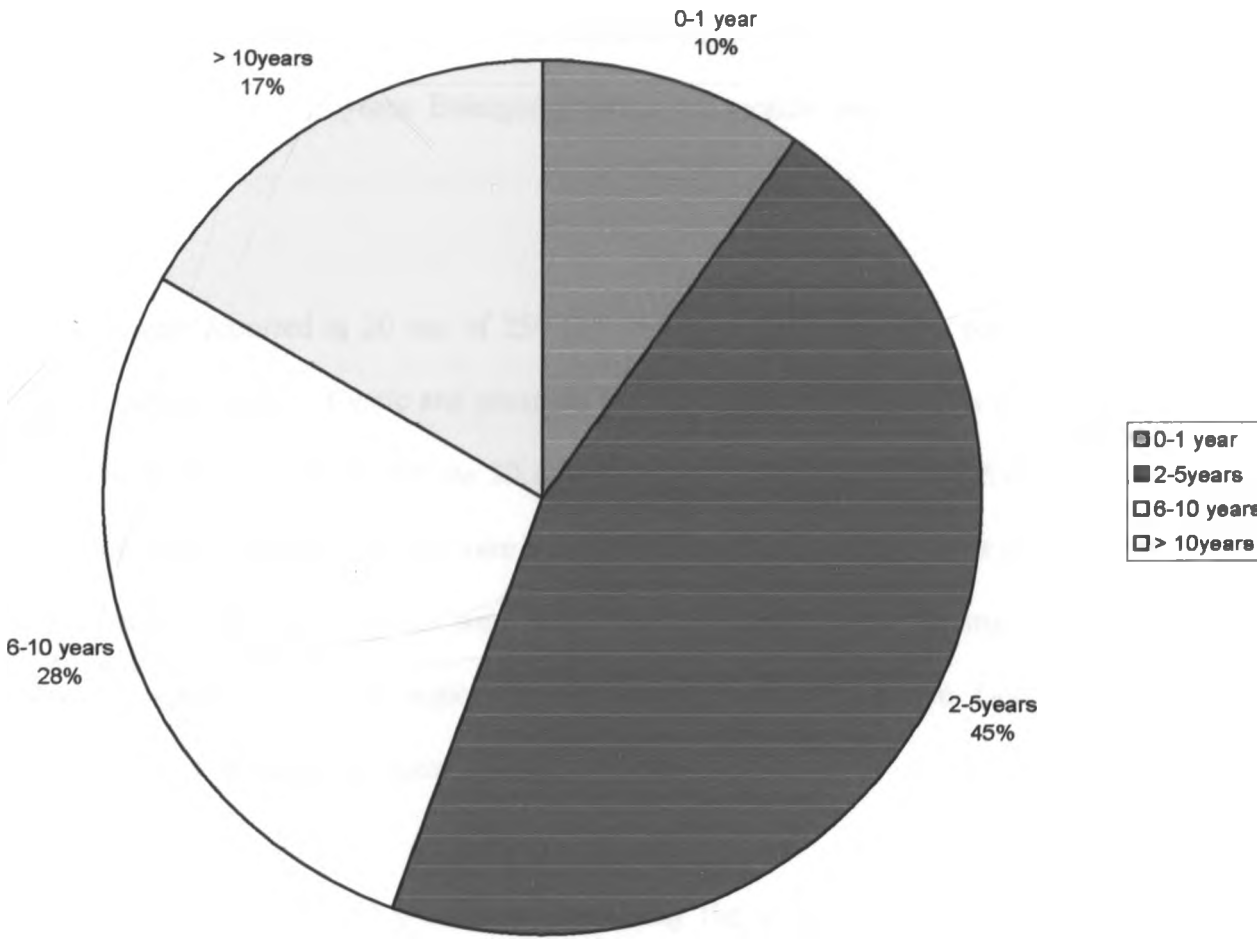


Figure 6. The type and frequency of conditions affecting the urinary system in dogs in the retrospective study

Age of the 254 dogs recruited in the retrospective study was categorized into four different levels. Dogs up to 1year old were 25 (10%), majority of dogs, 116, were between 2 to 5 years (46%). Those dogs aged between 6 to 10 years were 71 (27%) while 42 (17%) dogs were older than 10 years. The distribution of ages of dogs diagnosed with conditions affecting the urinary system is presented in **Chart 1**.

Chart 1. The age distribution of dogs diagnosed with conditions affecting the urinary system.



The age for most of the dogs with nephritis ranged from four months to twelve years. The condition was commonly diagnosed in dogs over five years old. Among the dogs with the three forms of nephritis, those over five years old represented 60.6%, and those less than five years old represented 39.4%. Two cases were diagnosed with concurrent interstitial nephritis and glomerulonephritis.

Cystitis occurred more frequently in male dogs than in females (ten cases in males versus two in females). A combination of cystitis and nephritis occurred in four cases that were all males aged 2, 6, 8 and 13 years. Enlarged prostate and cystitis was recorded in one case.

Renal tumors were reported in 20 out of 254 (7.9 %) dogs diagnosed with conditions affecting the urinary system. Cystic and prostatic tumors were diagnosed in six (2.4 %) and five (2 %) dogs respectively. Of the 20 cases with renal tumors, eight (40%) were primary tumors of the kidneys, the rest were metastatic tumors arising from other organs. The most common metastatic tumors were carcinomas metastatic from the mammary glands and lungs followed by hemangiosarcomas metastatic from the spleen. One case had osteosarcoma of the humerus metastatic to the kidneys.

Of the total 31 cases diagnosed with tumors affecting the urinary system following histopathological examination, 21 (67.7%) were males, while 10 (32.3%) were females. Tumors were commonly diagnosed in the age bracket between six years to 14 years.

4.2 PROSPECTIVE STUDY FINDINGS

4.2.1 PHYSICAL EXAMINATION FINDINGS

The 30 cases recruited into the study comprised of 11 (36.7%) females, and 19 (63.3%) males. The German shepherd dog (Alsatian) accounted for 57% of the cases. Crossbreeds were 33%, Rottweilers 6.7%, and Akitas 3.3%. The distribution of the breeds of dogs affected by conditions of the urinary system is presented in **Figure 7.**

Physical examination revealed clinical signs that included body wasting (12 cases), enlarged prostate (8 cases), pale mucus membranes (7 cases), urine incontinence (4 cases), halitosis (3 cases), excessive loss of the hair coat (3 cases), dehydration (2 cases) and oral ulcers (2 cases). These clinical findings are represented in **Figure 8.**

The most common clinical signs observed in dogs that were affected by conditions of the urinary system included wasting (40%), prostatic enlargement (26.7%), and pale mucus membranes (23.3%). The least frequent clinical signs observed were urinary incontinence (13.3%), halitosis (10%), excessive shedding of the hair coat (10%), dehydration (6.7%) and oral ulcers (6.7%).

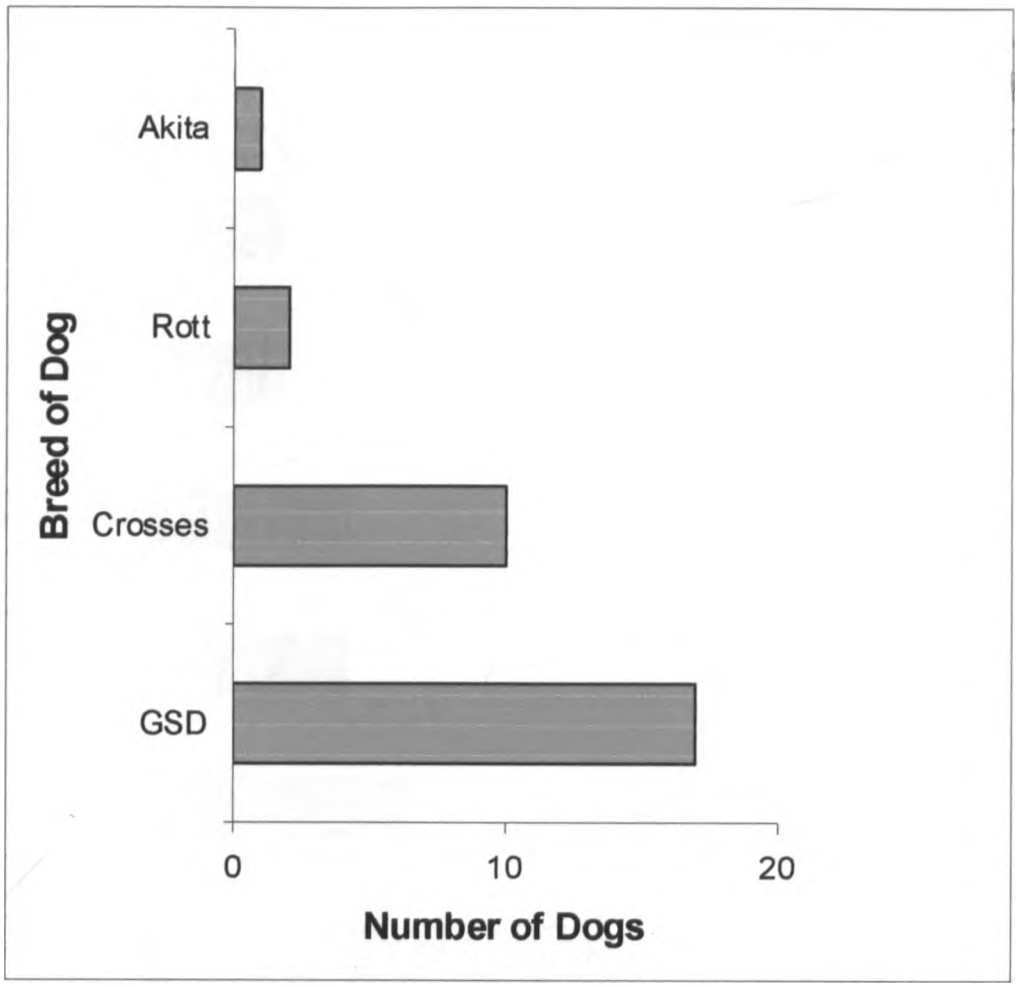


Figure 7. The distribution of breeds of dogs affected by conditions of the urinary system recruited into the prospective study

Key:

GSD = German Shepherd Dog

Rott = Rottweiler

Crosses = Cross breed dogs

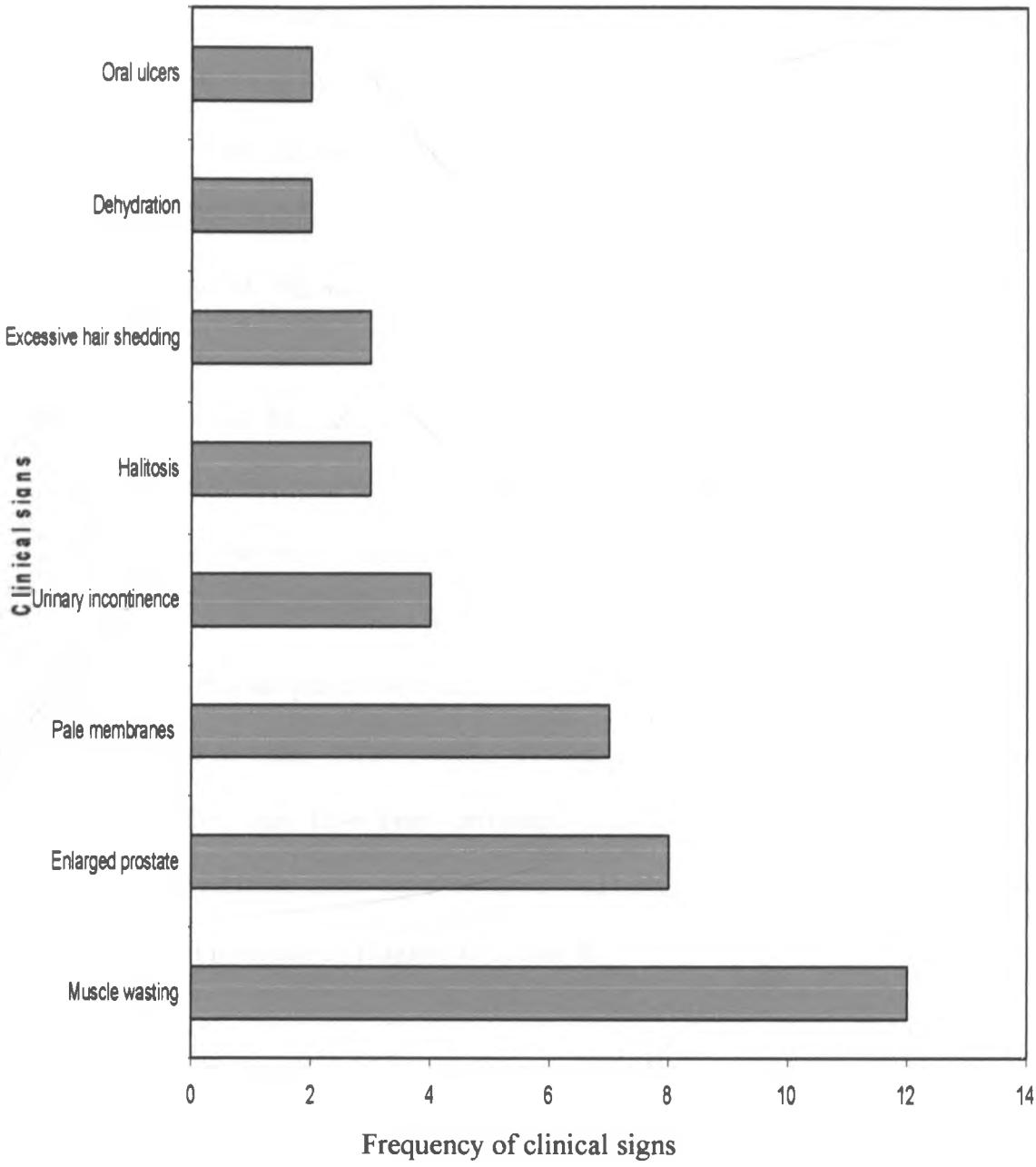


Figure 8. Frequency of clinical signs observed in dogs with conditions of the urinary system in the prospective study

4.2.2 URINALYSIS RESULTS

The urine specific gravity (USG) ranged from 1.000 to 1.035. Three out of 30 (10%) samples had a USG in the hyposthenuria range i.e. less than 1.008 (1.000, 1.005 and 1.005). The pH (8, 7 and 8) of these 3 cases was also elevated (alkaline). Two out of 30 (6.7%) samples were isothenuric these had a USG of 1.010 (**Figure 9**). 25 samples (83.3%) had USG within the normal range. All the urine samples with a cloudy appearance (7 out of 30), had sediment on centrifugation (**Figure 10**). The sediment consisted of casts, erythrocytes, leucocytes, epithelial cells and crystals; epithelial cells were seen in 6 out of the 7 cases, erythrocytes were present in 6 cases, leucocytes were present in 3 cases while casts were present in 3 cases of which 2 had granular casts and 1 was hyaline casts. No bacteria, yeast cells or parasitic eggs were seen.

Bilirubin levels were within normal range in 22 (73.3%) reduced in 7 (23.3%) and elevated in 1 (3.3%) sample(s). Hematuria was observed in 5 (16.7%) of samples. These cases with blood in urine were recorded without an associated owners' complaint of hematuria and they may have been iatrogenic since the urine was collected through cystocentesis. Crystals in urine were found in 7 (23.3%) cases which had urates in the urinary bladder at postmortem **(Figure 15 A and B)**.

Urine pH of the 30 samples ranged from 5 to 8 which is within the normal reference value for dogs and this is dependent on the dogs diet. 10 samples (33%) had a pH of 7, 5 samples (17%) a pH of 8, 6 samples (20%) a pH of 5 and 9 samples (30%) a pH of 6 **(Figure 11).**

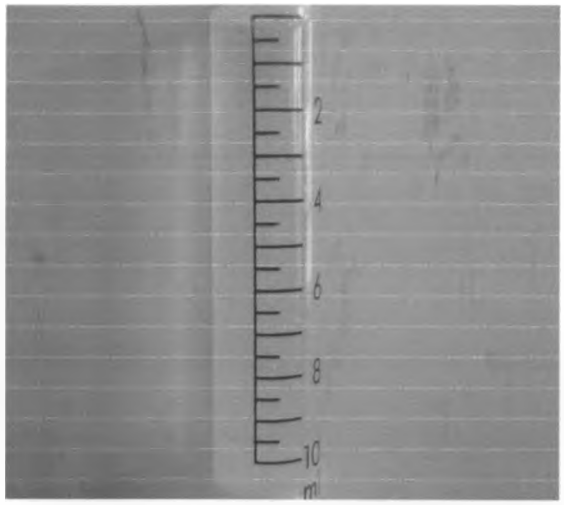


Figure 9. Isothenuric urine from a dog appearing colorless (Case number 16).

Figure 10. Sediment in the urine of a dog seen after centrifugation (Case number 15).

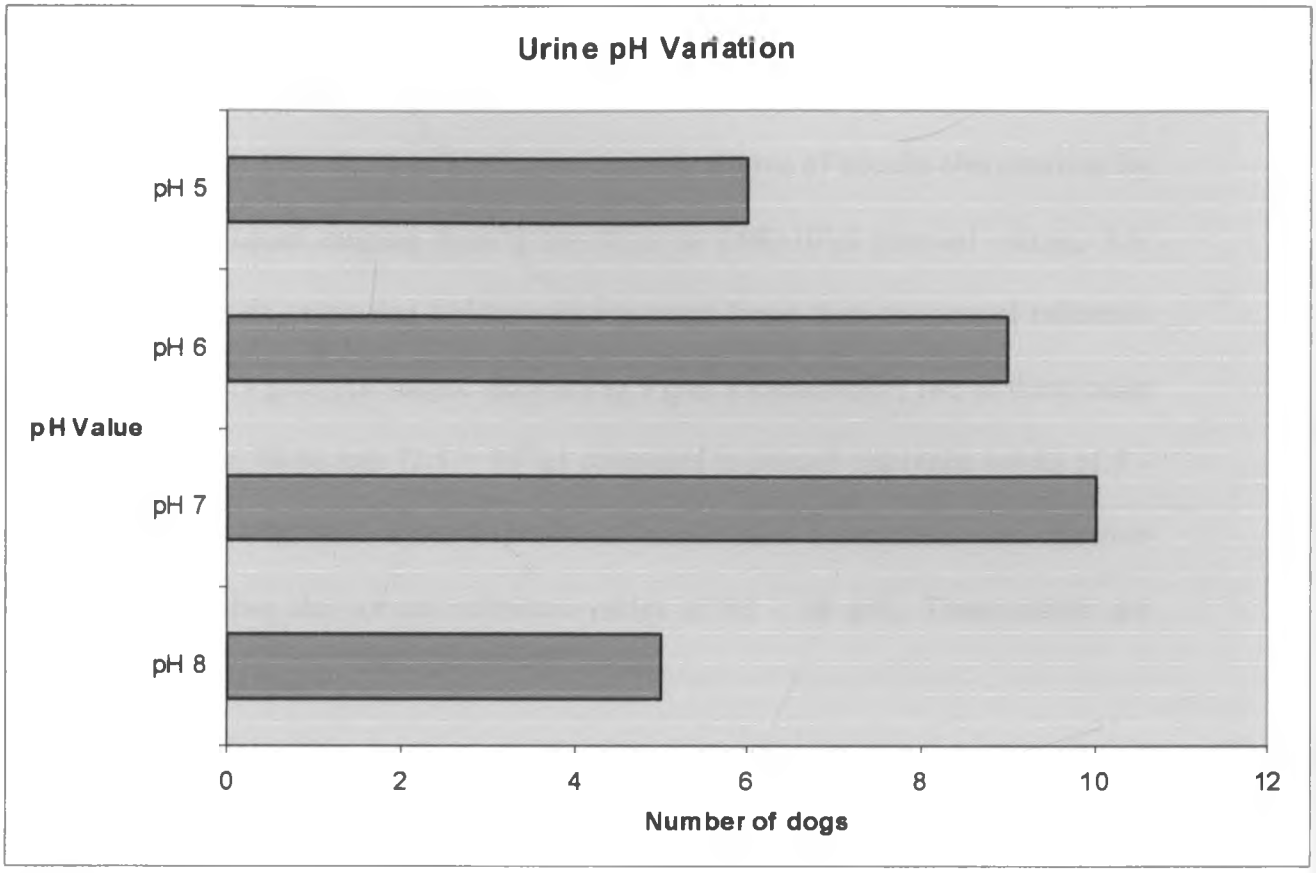


Figure 11. Urine pH in dogs with conditions affecting the urinary system.

4.2.3 HEMATOLOGY FINDINGS

The hematology results of the thirty cases recruited into the prospective study is represented in **Appendix 4.**

Six cases (20%); 4, 5, 8, 16, 18 and 25 had an extreme degree of anemia characterized by a red blood cell count ranging from $1.54\times10^6\mu l$ to $2.98\times10^6\mu l$ (normal values; 5.5-$8.5\times10^6\mu l$). These six cases also had hemoglobin count lower than the normal reference range of 11.9 – 18.9 g/dl; this ranged from 2.9 to 7 g/dl. Concurrently, two of these cases had a leucocytosis; 48.86 and 72.5 $\times$ $10^3/\mu l$ compared to normal reference values of 5 - 14$\times$ $10^3/\mu l$ while 4 of the 6 cases had a Mean corpuscular hemoglobin concentration (MCHC) higher than the normal reference values of 32 – 36 g/dl. These results are presented in **table 1** below.

Table 1 – Hematology findings for six dogs with extreme anaemia

Case No.	PCV	Hb	RBC	MCV	MCHC	WBC
	%	g/dl	$\times 10^6\mu l$	fl	%(g/dl)	$\times 10^3/\mu l$
Reference value*	**35 - 57**	**11.9 – 18.9**	**5.5 – 8.5**	**66 - 77**	**32 - 36**	**5.0 - 14.0**
8	7.2	2.9	1.54	47.3	40.2	11900
16	16.8	6.7	2.3	72	39.8	48860
4	40	4	2.58	45	32.8	7660
18	22	7	2.98	55.5	42.4	72490
5	25.7	9.4	3.7	69.5	36.5	9760
25	25	8.9	3.9	61.6	36.3	7100

KEY: No. – Number, PCV – Packed cell volume, Hb – Hemoglobin, RBC – Red blood cells, MCV – Mean corpuscular volume, MCHC – Mean corpuscular hemoglobin concentration, WBC – White blood cells

Eight more cases (26.7%) in addition to the six described above had a PCV marginally below the normal reference levels. Hemoglobin and RBC counts in these cases were also marginally below the reference values.

The white blood cell count was high in 12 (40%) cases (inclusive of the two cases described above). The additional 10 cases had hemoglobin levels within the normal reference values and the PCV was slightly below the reference value in only two of these. The packed cell volume was within normal range in 16 (53.3%) dogs.

Hemoglobin Concentration (Hb) in 10 cases (33.3%) cases recruited into the study was below the normal range. However, 19 cases (63.3%) had Hb within the normal range while 1 case (case number 29) had Hb, PCV and WBC values above the normal range. Overall, red blood cell (RBC) count was low in 13 cases (43.3%) (Includes the 6 cases described earlier) but it was within the normal range in seventeen (56.7%) cases.

The mean corpuscular volume i.e. the average volume of erythrocytes (MCV) was low in 10 cases (33.3%), this ranged in value from 45 – 62.9 femtoliters (fl) against the normal range of 66 – 77 fl. Three cases (10%) that is 4, 8 and 18 out of the 10 cases had a corresponding decrease in other erythron parameters except for PCV in case number 4 (as described in table 1). Overall, the mean corpuscular hemoglobin concentration (MCHC) was only slightly increased in 7 out of thirty (23.3%) cases and reduced in 1 case.

4.2.4 BIOCHEMISTRY FINDINGS

The results of the biochemical test on alkaline phosphatase, alanine aminotransferase, total protein, albumin, globulin, blood urea nitrogen, and creatinine are presented in **Appendix 5.** Alkaline phosphatase was markedly increased in 15 out of the 30 cases (50%), ranging from 120 to 1501 U/L as compared to normal of one to 114 U/L while the results of the other 15 cases were within normal. The results of alanine amino transferase (ALT) were largely unremarkable except in one case (3.3%) where it was elevated to 198.5 U/L compared to the reference values of 10 – 109 U/L. alanine amino transferase was within the normal reference values in 29 cases (96.7%).

Total protein was increased (hyperproteinemia) in 12 cases (40%), was within normal range in 17 (56.7%) cases but decreased (hypoproteinemia) in only one case. Albumin levels were decreased in 11 (36.7%) cases and subsequently globulin levels increased in the same cases. Serum albumin levels were increased in nine (30%) cases but were within normal range in 10 (33.3%) cases. The albumin globulin ratio was reduced in 14 (47.6%) cases, increased in seven (23.3%) cases but was within normal range in nine (30%) case.

Blood urea nitrogen (BUN) was increased in six cases (20%) and within normal range in 24 (80%) cases. Serum creatinine levels were increased in four cases (13.3%), but were within the normal range in 26 cases (93.3%).

4.2.5 RADIOGRAPHIC FINDINGS

The results of evaluation of the degree of opacification of the nephrogram and pyelogram, length of the kidneys in reference to lumbar vertebrae two and width of the kidneys of the cases recruited into the prospective study are presented in **Appendix 6.**

The renal pelvis was dilated in three out of the 30 cases (10%); they measured 0.5 cm to 1.5 cm on the lateral view radiograph (**Figure 12**). The normal is usually 0.2cm in diameter. The proximal ureters were dilated in four cases.

The size of the kidneys was evaluated by measuring the length of each on ventrodorsal (VD) view radiograph taken at five minutes after injection of the contrast media and compared to the length of lumbar vertebrae two (L2) that was measured on the same view. Normal kidneys should be approximately three times the length of L2. Renal size was normal in eight out of 30 cases (26.7%); there was a slight decrease in size of the kidney in ten cases (33.3%) and a slight increase in its size in six cases (20%). The range of increase and decrease in size was between 0.5 and 1.5 cm in relation to normal.

The urinary bladder was severely distended in one case on the lateral view taken at 40 minutes after injection of contrast, with many small discrete areas of increased radiopacity against a uniform background. An enlarged prostate gland was also seen at the pelvic inlet in the same case.

In two cases (6.7%), the urinary bladder wall was thickened at the craniodorsal and cranioventral borders respectively on the lateral view taken at 40 minutes post contrast

medium injection **Figure 13.** Discrete radiopaque areas were present in the renal pelvis of one case (renal calculi).

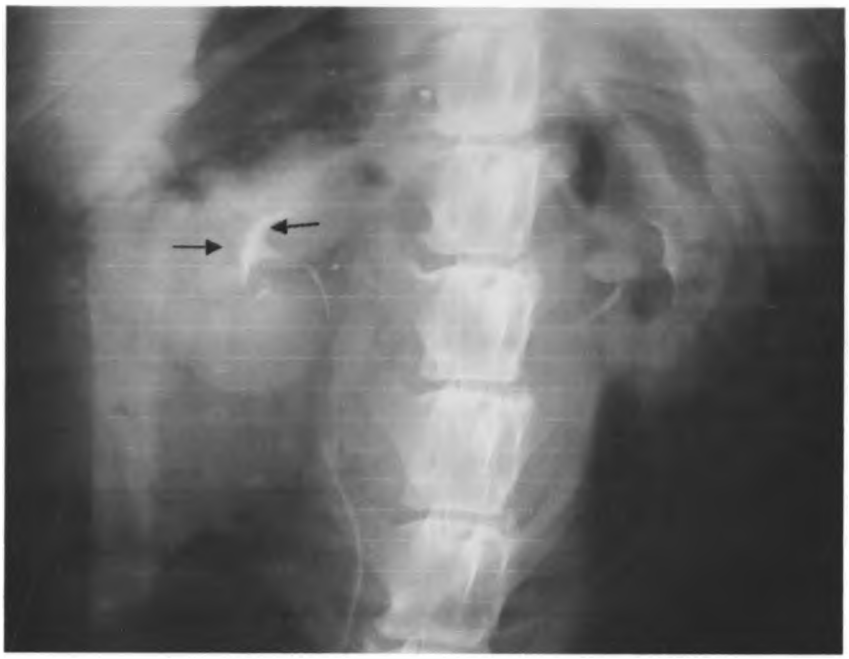


Figure 12 A. Dilated left renal pelvis on ventrodorsal view of intravenous pyelograph taken 20 minutes post contrast medium injection (black arrows)

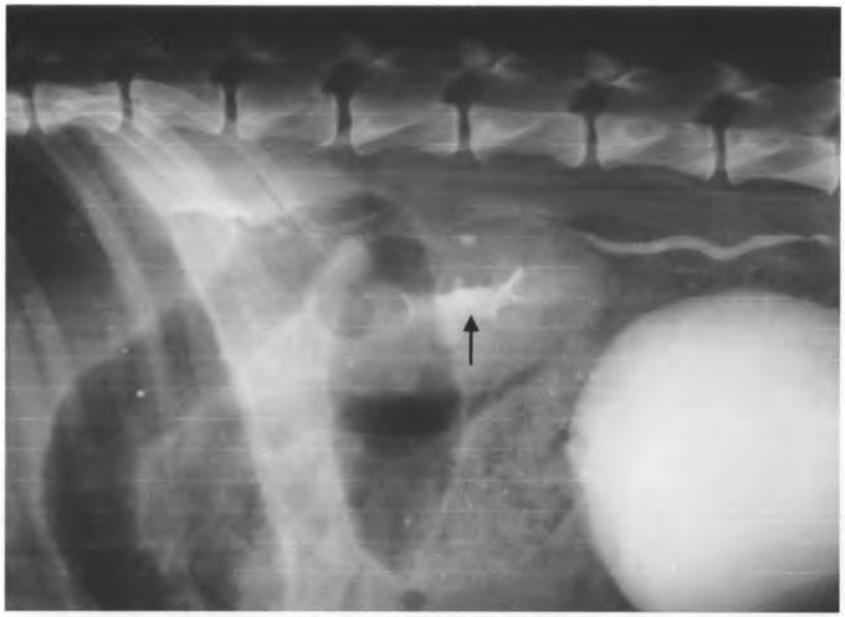


Figure 12 B. Dilated left renal pelvis on lateral view taken at 20 minutes post contrast medium injection (arrow)

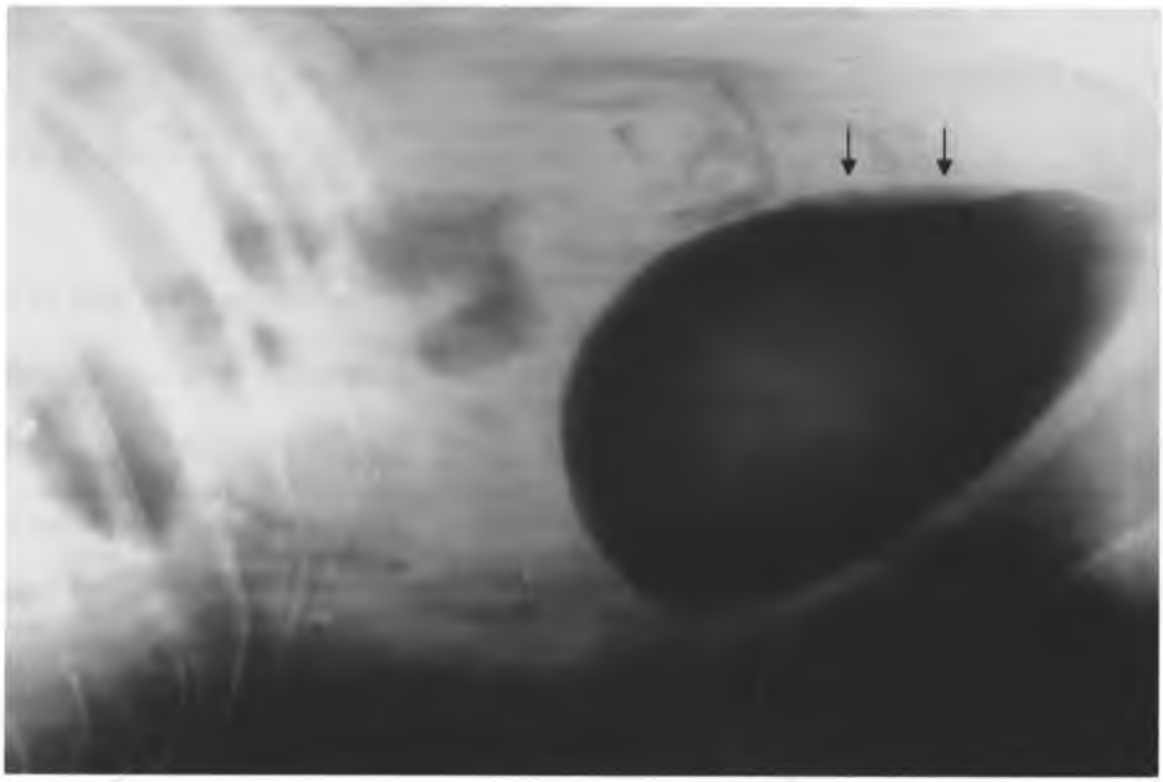


Figure 13. Thickened urinary bladder wall following double contrast (arrows).

4.2.6 GROSS POSTMORTEM FINDINGS

The distribution of lesions observed following postmortem examination of 30 dogs is presented in **Table 1.** Illustration of the major postmortem findings are shown in figures 14, 15, 16, 17 and 18.

The most frequently observed postmortem changes included scarring and pitting of the renal surface (26.7%), adherent renal capsule (26.7%), presence of urates in the urinary bladder (23.3%), and enlarged prostate glands (23.3%). The lesions that were moderate in frequency included presence of thick urinary bladder wall (16.7%), renal cysts (16.7%), pale kidneys (13.3%) and distended renal pelvis (10%). The least frequently encountered lesions were gastric ulcers (6.7%), renal uroliths (6.7%), bladder growths (3.3%) and renal infiltrations (3.3%).

The renal cysts were located in the cortex and were spherical in shape ranging from 1-2mm in diameter. They were thin walled and contained clear, watery fluid. All the seven (23.3%) cases with urates in the urinary bladder had yellow urates (**Figure 15**) and five out of the seven cases were in male dogs. Scarring and pitting of the renal surface extended into the cortex and this was usually accompanied by adhesion of the capsule. The kidneys with this lesion were firm on palpation. Prostate enlargement was seen in seven out of the 15 males (47%) recruited into the prospective study.

Table 2. Frequency of pathological lesions of the urinary system in 30 dogs.

PATHOLOGY	FREQUENCY (OUT OF 30)	PERCENTAGE
Renal scarring and pitting	8	26.7
Adherent capsule	8	26.7
Urates in the bladder	7	23.3
Enlarged prostate	7	23.3
Thickened bladder wall	5	16.7
Renal cysts	5	16.7
Pale kidneys	4	13.3
Distended renal pelvis	3	10.0
Gastric ulcers	2	6.7
Renal uroliths	2	6.7
Renal infiltrations	1	3.3
Urinary bladder growths	1	3.3

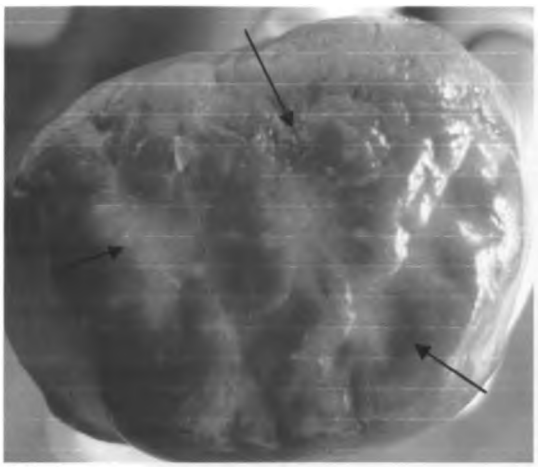


Figure 14 A

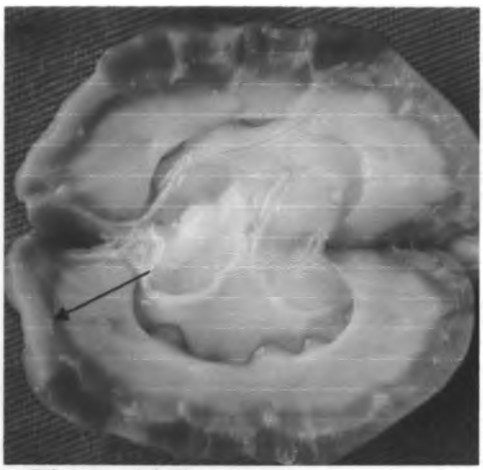


Figure 14 B

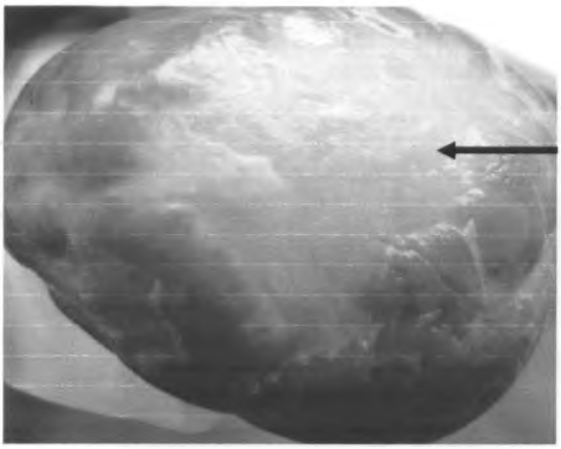
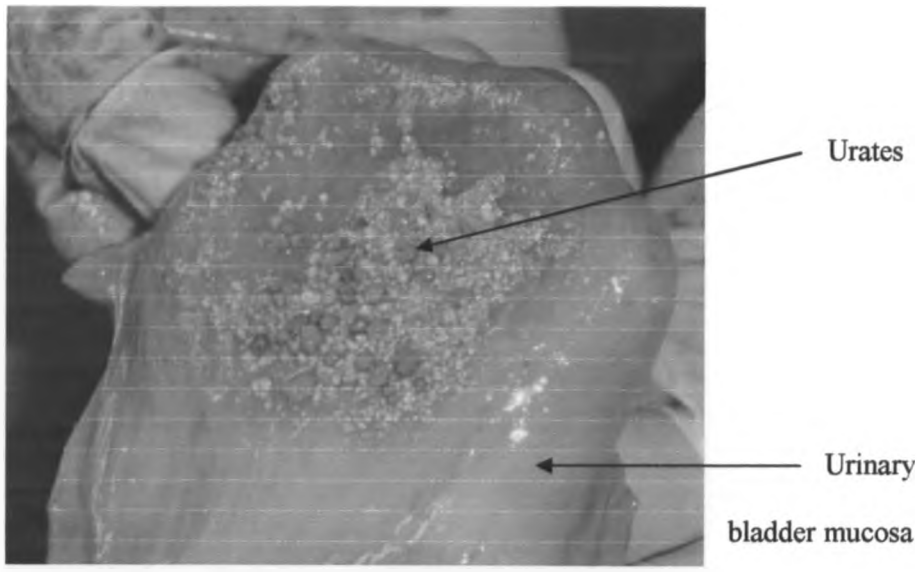


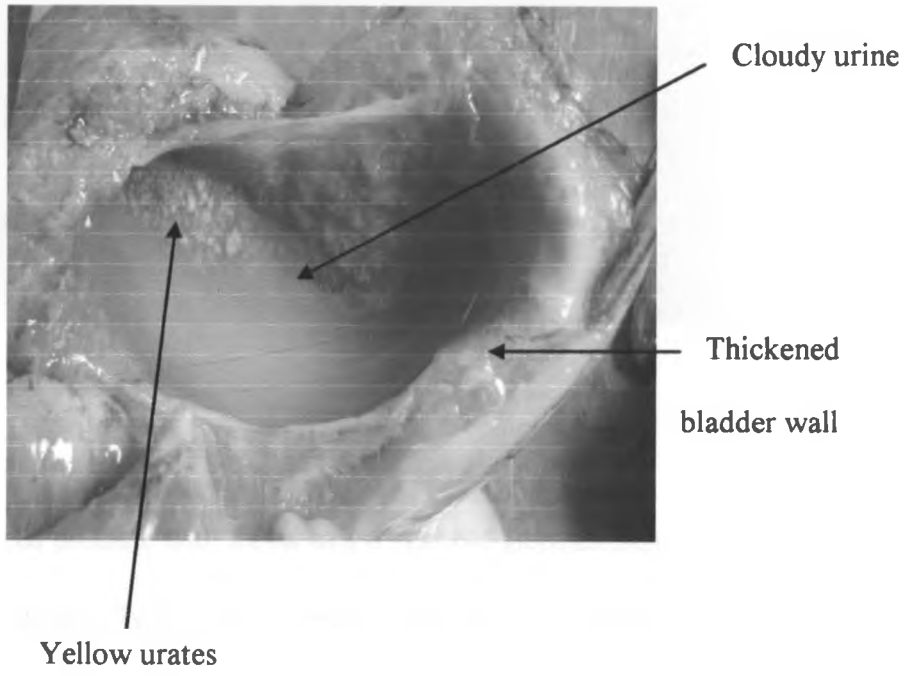
Figure 14 C

Figure 14 A and B (cut surface). Scarring and pitting of the kidney surfaces in a 7 year old Rottweiler Case number 16 (arrows)

Figure 14 C. Area of complete fibrosis on the craniodorsal border of the same kidney (arrow).



A) Case number 20



B) Case number 15

Figure 15 A and B. Yellow urates in the urinary bladder of 2 dogs, the second dog also had a thickened urinary bladder wall.

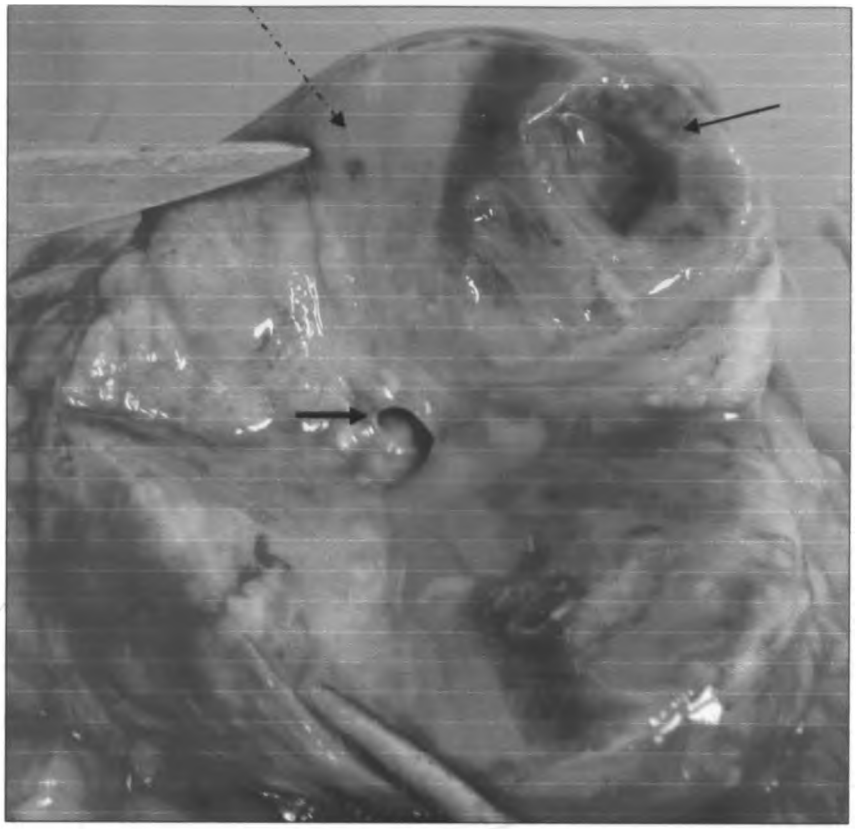


Figure 16. Enlarged prostate with a cyst in a 6 year old German Shepherd dog (Bold arrow points to the Urethra, narrow arrow points to the cyst and the broken arrow to the renal parenchyma)

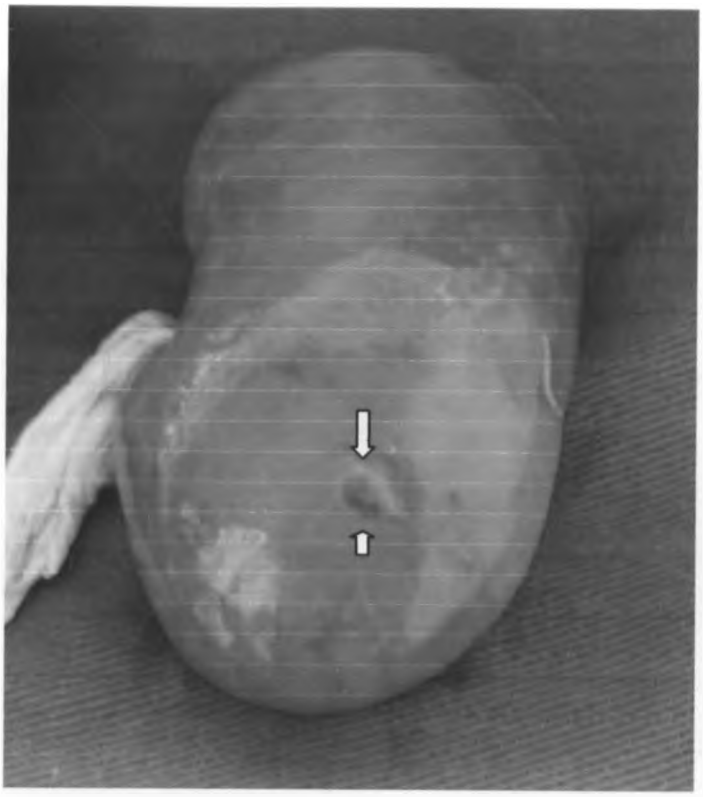


Figure 17. A cyst in the kidney (arrows) - Case number 25.

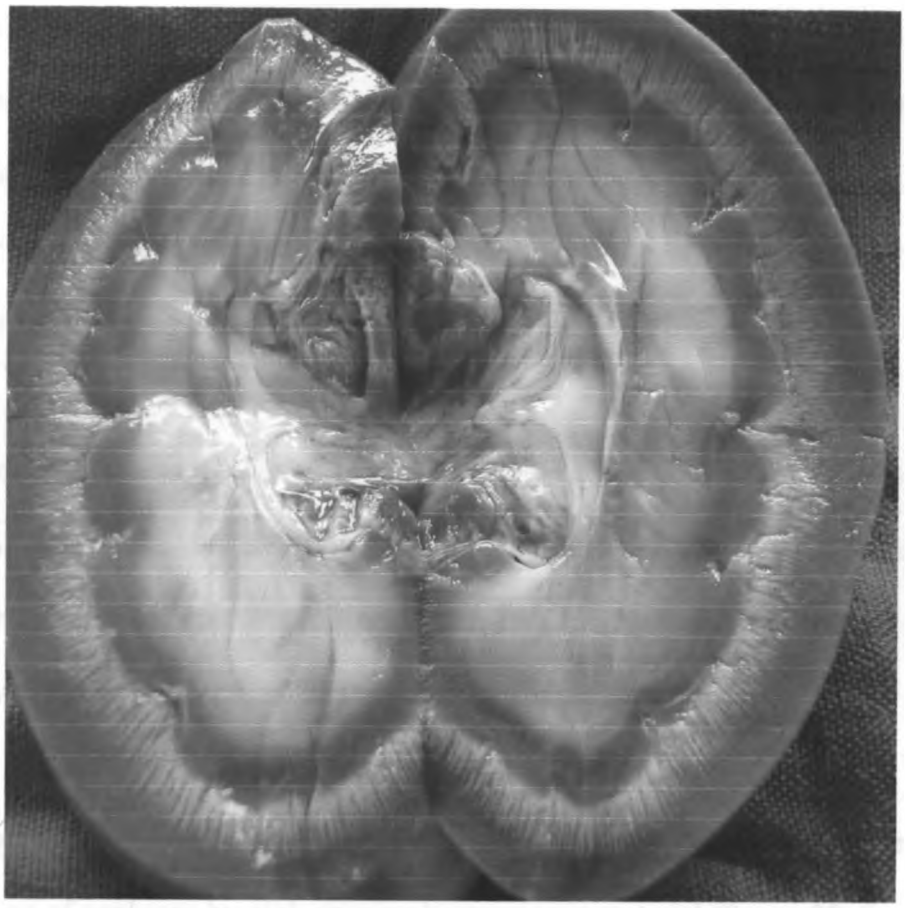


Figure 18. White infiltrations observed in the kidney cortex (Case number 5)

4.2.7 HISTOPATHOLOGY FINDINGS

The most common histopathological finding was infiltration of lymphoplasmacytic cells into the renal interstitium; this observation occurred in eight out of 30 cases (26.7%), this was accompanied by hypercellularity of the glomerular tuft at different levels, atrophy of tubular epithelium and hyalinization of the basement membrane. Such findings were concurrent with chronic interstitial nephritis. **Figure 19.**

Presence of microcysts within the renal parenchyma was observed in five out of 30 cases (16.7%). These occurred as amorphous spaces in the cortex. They were lined by a thin wall and showed evidence of urine stasis. This histopathological finding was seen in cases where renal cysts or uroliths were present at gross post mortem.

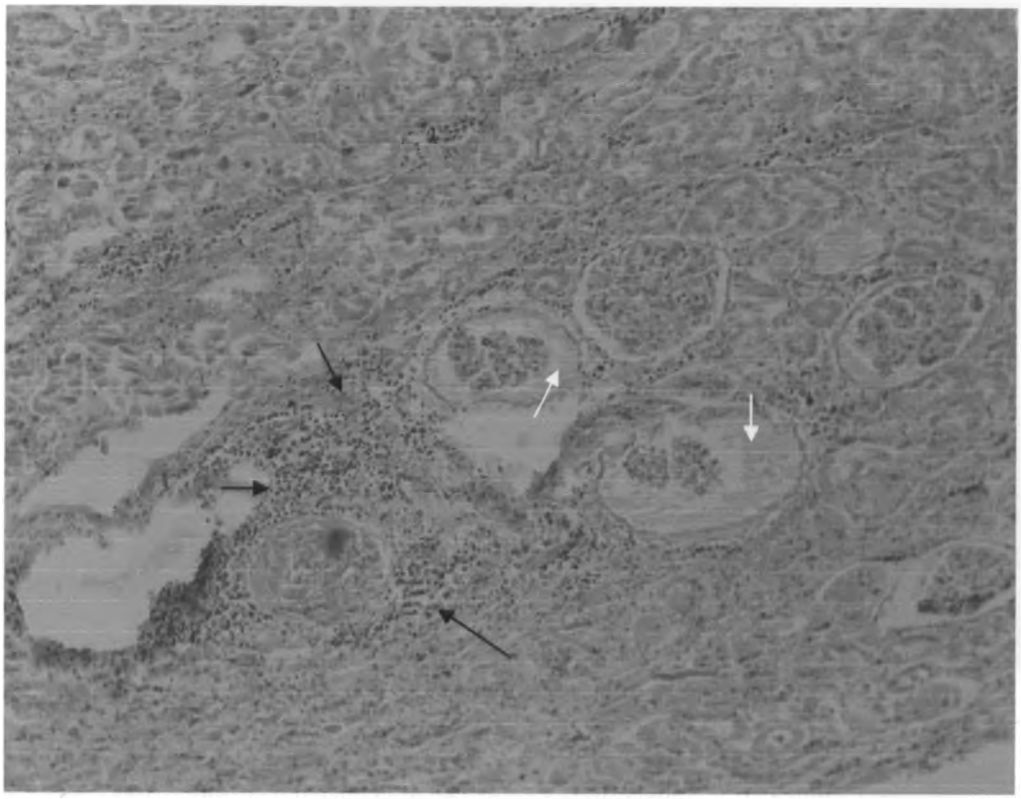
Hydronephrosis was diagnosed in one out of 30 cases (3.3%). This presented as varying distension of nephrons by pink staining homogenous material **Figure 20**. Some distended nephrons were occasionally empty but they were lined by atrophied epithelium. The hydronephrosis was complicated by presence of inflammatory foci within the renal parenchyma, and submerging of glomeruli by pink staining homogenous material that was accompanied by glomeruli tuft atrophy, thickening of glomerular basement membrane, thick walled arterioles with reactive intima of blood vessels, and areas of fibrosis.

Prostate hyperplasia in conjunction with prostatitis was diagnosed in two out of 30 cases (6.7%). These were seen as hypertrophy of the epithelium, fibrosis, presence of

inflammatory cells (neutrophils and macrophages), and glands that were poorly drained appearing cystic.

Two out of thirty cases were diagnosed with a combination of chronic interstitial nephritis and glomerulonephritis (6.7%). This was seen as infiltration with lymphoplasmacytic cells, tubular nephrosis with atrophy of tubular epithelium, casts within nephritic tubules, hyalinization of glomerular tufts, and connective tissue surrounding the nephritic tubules.

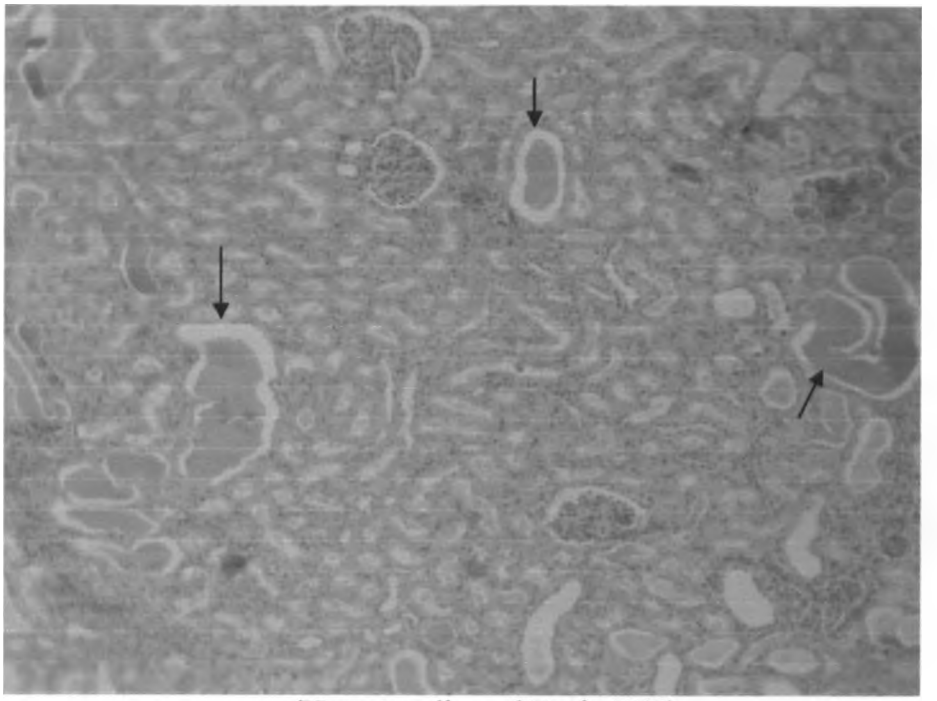
Chronic cystitis was seen as thickening of bladder epithelium (more than six cell layers), vascularisation of the subepithelium, epithelial necrosis, fibrosis of the lamina propria and infiltration of neutrophils and plasma cells. This was diagnosed in four cases out of 30 (13.3%).



(Hematoxylin and Eosin X40)

Figure 19. a) Lymphoplasmacytic infiltration into the renal parenchyma with nephritis seen as purple staining bodies (black arrows).

b) Pink staining proteineacous material in the glomerulus associated with tuft atrophy (white arrows).



(Hematoxylin and Eosin X40)

Figure 20. Pink staining homogenous material within the tubules of a dog representing urine stasis.

CHAPTER FIVE

5.0 DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 DISCUSSION

The study aimed at highlighting urinary system anomalies that went undetected due to other more obvious clinical diagnoses and the simple diagnostic tests that may be used. It represents the first original work describing the type and frequency of clinical, laboratory, radiographical and pathological data on conditions affecting the urinary system in dogs in Nairobi area, Kenya. The findings therefore provide an objective assessment of data on the indicative diagnostic value of clinical and pathological features of conditions of the canine urinary system of dogs in Nairobi, Kenya.

The high occurrence of dogs diagnosed with conditions of the urinary system in the retrospective study may have been due to the fact that more dogs were presented for postmortem examination at the University of Nairobi than other species (254 out of 1638 cases). In this study, it was noted that most of the cases were brought for postmortem examination with a clinical diagnosis that was unrelated to the urinary system. Postmortem confirmation of urinary conditions from these cases underscored the fact that most cases had been misdiagnosis or ignored during clinical assessment.

The observation that the German shepherd dog (GSD) and the cross breeds formed the highest percentage of breeds diagnosed with urinary system conditions, is attributed to the fact that these two are the most common breeds that constitute patient base at the University of Nairobi Small Animal Clinic and by inference are the most common breeds of dogs in Nairobi. The GSD and its crosses are commonly used as guard dogs among

security firms and homesteads in Nairobi. This observation was also noted in the prospective study in which the GSD formed the highest percentage (58%), followed by the Crossbreeds (33%). Although males were more represented in both the retrospective and the prospective studies, this difference was not clinically significant except in dogs afflicted with prostatic enlargement.

An important observation in the retrospective study was the high prevalence of conditions of the urinary system in the age bracket 2-5 years. It was expected that conditions affecting the urinary system would be more common in the older animals i.e. those greater than 6 years of age. This result further highlights the challenge that early and accurate diagnosis of conditions of the urinary (renal) system poses to clinicians. Juvenile nephropathy in immature or young adult dogs not associated with primary renal disease has been described by several authors (Peeters et al 2000, Mckay et al 2004, Chandler et al 2007).

The frequently observed clinical signs of wasting and pale mucous membranes may be attributed to delayed presentation of cases to the veterinarian. This delay meant that the patient had already lost body condition at the time of diagnosis and that the condition had progressed to chronic stages at the time of clinical examination; 8 out of the 30 cases in the prospective study had low hemoglobin and red blood cell counts. Blood parameters in renal diseases are severely affected in long standing renal disease due to the role of the kidneys in hematopoiesis (Smets *et al,* 2010). Alternatively, the condition may have been misdiagnosed and inappropriate therapeutic interventions instituted further resulting in progression of disease.

It is important to note that the renal system has extensive reserve capacity and ability to compensate, thus significant renal disease may be present without coexisting abnormal variation in clinical laboratory parameters consistent with renal failure (Duncan *et al.*, 1994). In the study hematology and biochemistry results were largely unremarkable even in cases that were found to have urinary system lesions on radiograpy or postmostem examination and this was attributed to the extensive reserve capacity of the kidneys. This fact highlights the need to combine clinical examination, laboratory tests, and radiographic examination when dealing with cases involving the urinary system in order to arrive at an accurate diagnosis.

In both the retrospective and prospective study, cystitis occurred more frequently in male dogs than in females contrary to what has been reported in literature; cystitis occurs more commonly in females due to the presence of a shorter urethra than in males. This was attributed to the fact that males were over represented in both studies. Similar tumors were also more common in males for the same reason.

Urine specific gravity (USG) of the 30 samples analyzed ranged from 1.000 to 1.035; a dog with a USG greater than 1.030 is presumed to have adequate urine concentrating ability (Jacob *et al.*, 2005; Smets *et al.*, 2010). Three samples that had a USG in the hyposthenuric range indicated that these dogs had a reduced ability to concentrate urine; the two samples that had a USG in the isothenuric range indicated inability to concentrate urine. These findings combined with gross postmortem and histopathology findings led to a diagnosis of interstitial nephritis for the samples with hyposthenuric urine and chronic glomerulonephritis for the samples with isothenuric urine. This implies that as expected,

demonstration of inability to concentrate urine is consistent with coexisting severe renal pathology.

Although only 32 out of 199 (16%) samples in the retrospective study were examined histologically, this proved valuable as it enabled the classification of nephritis. Chronic interstitial nephritis was the most common form of nephritis (50%), pyelonephritis accounted for 31.3% and glomerulonephritis 18.7%.

Practitioners should routinely submit samples of cases of renal disease in dogs for histopathology to obtain definitive diagnoses. This would further assist in accurate and early diagnosis as the histopathology results would then be looked at in combination with the clinical and laboratory findings which will then form a reference for future cases.

An interesting observation was the fact that in the prospective study, interstitial nephritis was more commonly diagnosed on histopathological examination. The condition was associated with lymphoplasmacytic infiltration in the renal interstitium; chronic interstitial nephritis and glomerulonephritis constituted 6.7%. The study findings are consistent with previous reports that interstitial nephritis is more common in dogs and it is usually a relatively acute disease when compared to glomerulonephritis which is a more chronic disease process (Grauer, 2005; Smets *et al.*, 2010).

Pale kidneys, renal scarring and pitting and adherent renal capsule were postmortem findings noted in the cases that showed nephritic changes on histopathology. The same gross postmortem findings were also seen in the three cases in the prospective study that were greater than 6 years old.

Contrast radiography was found to be a useful tool in the diagnosis of conditions affecting the urinary system in dogs. This is due to the fact that some of the morphological changes that aid in clinical diagnosis of conditions of the urinary system are only visible on contrast radiography. These include changes in the pelvic recesses, the renal pelvis, and the ureters (Feeney and Johnston, 2002).

In contrast radiography, the degree of nephrographic and pyelographic opacification in combination with the fading patterns of the nephrogram was successfully used to qualitatively estimate the renal function (Feeney and Johnston, 2002). The poorer the renal function, the less opacified were the nephrographic and pyelographic phases of the excretory urogram. One case did not have both the nephrographic and pyelographic phase of the excretory urogram which indicated the presence of end stage chronic renal failure. This finding was confirmed by the biochemistry, urinalysis, postmortem and histopathology findings which supported the diagnosis of chronic glomerulonephritis in this case. Contrast radiography was also useful in assessing location, size and shape of the kidneys as well as the urinary bladder.

The study presents baseline data on urinary conditions in dogs in Nairobi area, Kenya based on clinical, laboratory and pathologic features, and represents a data base of indicative diagnostic features of conditions of the urinary system in dogs. This study can extend to other animal species and should offer a quick reference to the status of renal disease in dogs in Nairobi, Kenya.

5.2 CONCLUSIONS AND RECOMMENDATIONS

5.2.1 CONCLUSIONS

This study provides useful information on prevalence and diagnostic indicators of conditions of the urinary system in dogs in the Nairobi area based on clinical laboratory, radiographic and pathologic features.

The combination of the diagnostic tools; clinical examination, laboratory test, survey and contrast radiography, gross post mortem and histopathology were useful in arriving at an accurate diagnosis of these conditions. A correct diagnosis means appropriate and timely therapeutic intervention which translates to an improved prognosis for patients.

This study also confirms that contrast radiography is a useful diagnostic tool for the urinary system in dogs. The study showed that this is an easy procedure to carry out and that the contrast agents available in the market are largely safe for use in the dog. In an ideal hospital setting, this form of radiology should be adopted for routine clinical diagnosis since it enhances accurate diagnosis where other tests may be inconclusive. However performing contrast radiography requires patience and some significant cost is involved.

Contrary to what is documented in literature, this study revealed that conditions of the urinary system were more common in the young adult dog (2 to 5 years). It was concluded that laboratory tests that are specific for the urinary system should be included in the diagnostic work schedule to improve the chances of early diagnosis and treatment which should improve the prognosis of these conditions.

The data documented in this study should motivate further studies aimed at improving the overall understanding of the diagnostic features that will improve therapeutic interventions and prognosis of conditions of the urinary system.

5.2.2 RECOMMENDATIONS

1) Contrast radiography (intravenous pyelography) is recommended for clinical veterinary practice as a tool to aid in accurate and timely diagnosis of conditions involving the urinary system.

2) More investment should be put into training in veterinary urology in Kenya to enhance accurate and early diagnosis and appropriate therapeutic interventions of conditions of urinary system in animals.

3) Continuing education on diseases of urinary system should be integrated in the profession to increase awareness to the veterinarian and the pet owner of the changing trends in veterinary urology.

CHAPTER SIX

6.0 REFERENCES AND APPENDICES

6.1 REFERENCES

Banks, W. J. (1993). Urinary System. Applied Veterinary Histology 3rd Edition. Mosby, Inc. 374-387.

Barsanti, J. and Finco, D. (1979). Protein concentration in urine of normal dogs. American Journal of Veterinary Research **40**(11): 1583-1588.

Bergstein, J. (1999). A practical approach to proteinuria. Pediatric Nephrology **13**(8): 697-700.

Bradley, K. (2003). Intravenous urography – Technique and Normal Appearance. UK VET: The Journal for the Veterinary Surgeon in General Practice. **8**(1): 40-42.

Braun, J. P., Lefebvre, H. P. and Watson, A. D. J. (2003). Creatinine in the Dog: A Review. Veterinary Clinical Pathology. **32**: 162 – 179.

Campbell, N. (1990). Controlling the Internal Environment. Biology. Redwood City, The Benjamin/Cummings Publishing Co., Inc.: 890.

Carlton, W. W. and McGavin, M. D. (1995) Reproductive System: Male. In '' Special Veterinary Pathology 2nd Edition'' , Ladig, D., Mosby: Ch. 13

Chandler, M. L., Elwood, C., Murphy, K. F., Gajanayake, I. and Syme, H. M. (2007). Juvenile Nephropathy in 37 Boxer Dogs. Journal of Small Animal Practice. **48**: 690 – 694.

Cortadellas, O., Fernandez del Palacio, M. J., Talavera, J. and Bayon (2008). Glomerular Filtration Rate in Dogs with Leishmaniasis and Chronic Kidney Disease. Journal of Veterinary Internal Medicine. **22**: 293 – 300.

DiBartola, S. P. (1995) Clinical Approach and Laboratory Evaluation of Renal Disease. In "Textbook of Veterinary Internal Medicine 4th Edition", Ettinger, S J and Feldman, E C, W B Saunders Co.: Ch. 132.

Duncan, J. R., Prasse, K. W. and Mahaffey, E. A. (1994). Urinary System. In "Veterinary Laboratory Medicine: Clinical Pathology 3rd Edition", Iowa State University Press. 162-182.

Essman, S. C. (2005). Contrast Cystography. Clinical Techniques in Small Animal Practice **20**:46-51 Elsevier Inc.

Feeney, D. A. and Johnston, G. R. (2002). The Kidneys and Ureters. In "Textbook of Veterinary Diagnostic Radiology, 4th Edition", Thrall, D.E. W. B. Saunders Co. 556-569.

Finco, D. R. (1997). Kidney Function. In "Clinical Biochemistry of Domestic Animals" 5th Edition, Academic Press: 441-480.

Gamer, B. C. and Weidmeyer C. E. (2007). Comparison of a semiquantitative point of care assay for the detection of canine microalbuminuria with routine semiquantitative methods of proteinuria. Veterinary Clinical Pathology. **36**: 240 – 244.

Gassee, J. and Verniory, A. (1977). Current concept of the mechanism of proteinuria. Veterinary Clinical Pathology. **53**(24): 1480-1488.

Grauer, G. F. (2005). Renal disease in the canine patient. Journal of Small Animal Practice. **46**: 469 – 478.

Guyton, A. and Hall, J. (1998). Urine Formation by the Kidneys: Glomerular Filtration and Renal Blood Flow. In "Textbook of Medical Physiology". Philadelphia, W B Saunders Co.: pp 315-358.

Henrikson, C. (1998). Urinary system. In "Textbook of Veterinary Histology". H. Dellman and J. Eurell. Baltimore, Williams & Wilkins: pp 203-223.

Heuter, K. J. (2005). Excretory urography. Clinical Techniques in Small Animal Practice **20**:39-45.

Jacob, F., Polzin, D. J., Osborne, C. A., Neaton, J. D., Kirk C. A., Allen, T. A., Swanson, L. L. (2005). Evaluation of the Association Between Initial Proteinuria and

Morbidity Rate or Death in Dogs with Naturally occurring Chronic Renal Disease. Journal of American Veterinary Medical Association. **226**: 393 – 400.

Kerl, M. E. and Cook, C. R. (2005). Glomerular Filtration Rate and Renal Scintigraphy. Clinical Techniques in Small Animal Practice **20**:31-38.

Lavoue, R., Van der Lugt, J. J., Day, M. J., George, M., Busoni, V., Merveille, A. C., Poujade, A. and Peeters, D. (2010). Progressive Juvenile Glomerulonephropathy in I6 related French Mastiff (Bordeaux) Dogs. Journal of Veterinary Internal Medicine. **23**:1-9

Lees, G. E. (2004). Early Diagnosis of Renal Disease and Renal Failure. Veterinary Clinics of North American Small Animal Practice **34**: 867-885.

Lefebvre, H. P., Dossin, O., Trumel, C. and Braun, J. P. (2008). Fractional Excretion Tests: A Critical Review of Methods and Applications in Domestic Animals. Veterinary Clinical Pathology. **37**(1): 4 – 20

Lillehoj, E. and Poulik, M. (1986). Normal and abnormal aspects of proteinuria. Part I: Mechanisms, characteristics, and analyses of urinary protein. Part II: Clinical considerations. Experimental Pathology **29**(1): 1-28.

Lulich, J. P., Osborne, C. A., Bartges, J. W. and Polzin, D. J. (1995). Canine Lower Urinary tract disorders. In "Textbook of Veterinary Internal Medicine" 4th Edition, Ettinger, S J and Feldman, E C, W B Saunders Co.: Ch. 141.

Murgier, P., Jakins, A., Bexfield, N., and Archer, J. (2009). Comparison of semiquantitative test strips, urine protein electrophoresis and an immunoturbidimetric assay for measuring microalbuminuria in Dogs. Veterinary Clinical Pathology **38**(4): 485 – 492.

McKay, L. W., Seguin, M. A., Ritchey, J. W., and Levy, J. K. (2004). Juvenile Nephropathy in two related pembroke Welsh Corgi puppies. Journal of Small Animal Practice **45**: 568 – 571.

Nakamura, M., Takahashi, M., Ohno, (2008). C-reactive protein concentration in dogs with various diseases. Journal of Veterinary Medicine Science **70**: 127 – 131.

Park, R. D. and Wrigley, R. H. (2002). The Urinary Bladder. In "Textbook of Veterinary Diagnostic Radiology, 4th Edition", Thrall, D E, W B Saunders Co. 571-586.

Pechman, R. D. Jr. (2002). The Urethra. In "Textbook of Veterinary Diagnostic Radiology, 4th Edition", Thrall, D E, W B Saunders Co. 588-592.

Peeters, D., Clercx, C., Michiels, L., Desmecht, D., Snaps, F., Henroteaux, M. and Day M. J. (2000). Juvenile nephropathy in a Boxer, a Rottweiller, a Collie and an Irish Wolf Hound. Australian Veterinary Journal **78**(3): 162 – 165.

Pollen, S. M. (2001) Renal Disease in Small Animals: A Review of conditions and potential nutrient and botanical interventions. Alternative Medical Review; **6** (Suppl): S46-S61).

Price, R. G. (2002). Early Markers of Nephrotoxicity. Compendium of Clinical Pathology **11**: 2-7.

Reine, N. J. and Langston, C. E. (2005). Urinalysis Interpretation: How to squeeze out the maximum information from a small sample. Clinical Techniques in Small Animal Practice **20**:2-10.

Scaglione, F. E., Catalano, D., Bestonoso, R., Bravida, C., D'Angelo, A., Zanatta, R., Cornaglia, S., Cornaglia, E., and Capucchio, M. T. (2008). Comparison between light and electron microscopy in canine and feline renal pathology: A Preliminary Study. Journal of Microscopy **232** (3): 387 – 394.

Smets, P. M. Y., Meyer, E., Maddens, B. E. J., Duchateau, L. and Daminet, S. (2010). Urinary markers in healthy young and aged dogs and dogs with chronic kidney disease. Journal of Veterinary Internal Medicine **24**: 65 – 72.

Vanden, S. L., Levine, J. F., Lees, G. E., Groman, R. P., Grauer, G. F. and Forrester, S. D. (2005). Renal Biopsy: A retrospective study of methods and complications in 283 dogs and 65 Cats. Journal of Veterinary Internal Medicine **19**: 794 – 801.

6.2 APPENDICES

Appendix 1 – List of conditions of the Urinary system in dogs.

A) Renal Conditions	**B) Ureteral Conditions**
Developmental abnormalities; ▪ Aplasia, ▪ Hypoplasia, ▪ Dysplasia, ▪ Progressive juvenile nephropathy, ▪ Ectopic and fused kidneys, ▪ Renal cysts Canine Fanconi-like syndrome Renal infarction Renal cortical necrosis Hydronephrosis Pyelonephritis Glomerulonephritis Glomerular amyloidosis Tubulointerstial nephritis, interstitial nephritis Renal nematodes – *Dioctophyma renale, Capillaria plica* Neoplasia – adenomas, carcinomas, nephroblastomas, lymphosarcoma. Nephrolithiasis	Congenital anomalies – duplication, valves, ectopia Vesicoureteral reflux Ureterovaginal fistuli Neoplasia Trauma Obstruction Calculi Ureteritis **C) Conditions of the Urinary Bladder and Urethra** Calculi Cystitis Neoplasia Traumatic rupture/perforation Congenital anomalies – patent urachus, Foreign bodies Urethritis Incontinence

Appendix 2

Clinical examination record sheet

Date _____ Case Number _____
Patient _____ Owner _____
Breed _____ Sex _____ Age _____
Chief Complaint _____
_____
Medical History _____

General Assessment

Body condition _____
Temperature _____ Heart Rate _____ Respiratory Rate _____
Mucus membrane colour _____
Hydration Status _____

Abdominal Palpation

Kidney size, shape and location _____
_____
Bladder size and location _____
Presence/absence of pain _____

Hematology

PCV _____ RBC Count _____ Hemoglobin conc. _____
WBC _____

Biochemistry

Serum creatinine _____ Urea Nitrogen _____ Na _____ Ca _____
HCO3 _____ P _____ Alk. Phosphatase _____

Urinalysis. Method of collection
_____
Colour _____ Appearance _____ pH _____
Specific Gravity _____ Protein _____ Glucose _____
Ketones _____ Blood _____ Bilirubin _____
Sediment _____
_____

Survey Radiography

Ventrodorsal view _____
_____
Lateral View _____
_____

Contrast Radiography

Ventrodorsal Views _____
_____
_____
_____
Lateral Views _____
_____

Postmortem Findings _____
_____

Diagnosis

Treatment

Appendix 3.

Retrospective study record sheet

Case number _____ Post mortem case number _____
Patient _____ Owner _____
Breed _____ Sex _____ Age _____
History _____

Presenting Signs _____
_____
_____
Clinical Diagnosis _____

Confirmatory Tests

Radiography: _____
_____
_____
Laboratory Tests: _____
_____
_____
_____
Treatment: Medical _____

Surgical _____
Post mortem findings: Gross Pathology _____
_____
_____

Histopathology _____
_____
_____

Conclusion

_____
_____
_____
_____

Appendix 4.

Hematology results of dogs recruited into the prospective study of urinary conditions of dogs in Nairobi

Case No.	PCV %	Hb g/dl	RBC $\times 10^6$µl	MCV fl	MCHC %(g/dl)	WBC $\times 10^3$/µl
1	36	11.1	5	65.3	33.2	10700
2	34	11	4.84	63.8	35.3	8280
3	30.8	10.7	5.6	55	34.7	9230
4	40	4.0	2.58	45	32.8	7660
5	25.7	9.4	3.7	69.5	36.5	9760
6	45.8	16.6	6.68	68.7	36.2	12500
7	37.8	13.6	5.27	71.9	35.9	32880
8	7.2	2.9	1.54	47.3	40.2	11900
9	33.2	13.1	5.75	57.9	39.4	22180
10	39.8	13.5	5.52	72.2	33.9	13410
11	37.9	12.8	5.37	70.7	23.8	12360
12	42	13.5	5.94	69.1	36.4	7230
13	36.6	13.6	6.0	61	37.1	10160
14	37	13.2	5.37	69	35.6	16460
15	43	15	7.1	65	33.9	15200
16	16.8	6.7	2.3	72	39.8	48860
17	35	12.2	6.2	68	34.8	18100

Appendix 4 continued

18	22	7.0	2.98	55.5	42.4	72490
19	31	10.9	5.7	62.1	37	9250
20	33	13.6	5.92	70.1	38.2	17100
21	39	13	8.2	74	35.8	16800
22	47.5	16.4	6.8	75	34.6	17600
23	31.3	12	4.5	68.9	38.3	45007
24	34	11.8	6.2	76.1	36.8	12100
25	25	8.9	3.9	61.6	36.3	7100
26	34	13.4	5	62.9	32.1	11200
27	38	13.8	7.2	62.8	40	8600
28	35.9	17	7.9	75	35.8	10400
29	55.4	21.9	7.27	76.3	39.5	35430
30	31.3	12	4.5	68.9	38.3	45070
Reference value*	35 - 57	11.9 – 18.9	5.5 – 8.5	66 - 77	32 - 36	5 - 14

*reference values adapted from Duncan et al (1994) - Veterinary Laboratory Medicine Third Edition

KEY:

PCV	Packed cell volume
Hb	Hemoglobin concentration
RBC	Red blood cell count
MCV	Mean corpuscular volume
MCHC	Mean corpuscular hemoglobin concentration
WBC	White blood cell count
fl	Femtoliters

Appendix 5.

Serum Biochemistry results of dogs recruited into the prospective study of urinary conditions of Dogs in Nairobi.

Case No.	Alk. Php U/L	ALT U/L	Total protein g/dl	Albumin g/dl	Globulin g/dl	A:G ratio	BUN mg/dl	Creatinine mg/dl
1	1501	198.5	8.2	1.9	6.3	0.3	7.64	0.6
2	193	25.7	4.5	2.1	2.4	0.88	18.69	0.5
3	179	73.5	9.9	2.9	7.0	0.4	33.8	1.0
4	171	14.6	8.8	3.7	5.1	0.7	12.0	0.8
5	48	23.3	8.9	2.2	6.7	0.3	24.8	1.2
6	271	11.5	9.0	5.3	3.7	1.4	33.9	1.4
7	247	52.4	7.7	3.9	3.6	1.1	29.3	2.6
8	343	24	15.2	3.1	12.1	0.3	9.4	0.7
9	291	19.3	5.9	2.1	3.8	0.4	16.8	0.6
10	111	30	5.3	1.9	3.4	0.4	25.7	1.1
11	123	45	7.0	2.0	5.0	0.4	18.1	0.5
12	166	38.9	8.3	2.2	6.1	0.36	9.7	1.3
13	120	24.5	8.4	3.1	3.7	1.2	16.31	0.5
14	282	16.4	8.5	2.0	6.5	0.3	22.9	1.4
15	121	19.2	6.4	3.2	3.2	1.0	31.9	2.0
16	105	65	6.9	1.6	5.3	0.3	29.7	1.5
17	180	70	6.9	1.6	5.3	0.3	18.2	1.1

Appendix 5 continued

18	97	31	9.2	2.5	6.7	0.4	20.3	1.6
19	58	48.2	6.1	4	3	1.9	16.6	1.8
20	101	51	7.0	3.8	2.6	1.1	24.2	0.7
21	76	10.8	5.8	2.7	2.2	0.8	8.9	1.4
22	85	56	6.8	3.2	3.5	1.2	20.1	0.5
23	100	28.7	7.2	3	3.6	1.1	14.7	1.3
24	45	50.2	6.4	2.8	3.4	0.7	25.6	0.4
25	105	22.1	6.0	2.3	3.7	0.6	19.0	1.6
26	188	89.1	9.1	2.2	6.9	0.3	52.3	0.8
27	40.7	45	7.0	3.4	2.9	1.6	11.6	1.7
28	12.2	10.9	5.7	2.6	3.2	0.7	16.8	0.6
29	90	23	7.4	3.2	2.4	1.2	19.8	1.2
30	65	48.6	5.5	4	3.6	1.8	26.2	1.8
Reference value*	1-114	10-109	5.4-7.5	2.3-3.1	2.7- 4.4	0.6-1.1	8-28	0.5-1.7

*reference values adapted from Duncan et al (1994) in Veterinary Laboratory Medicine Third Edition

KEY:

Alk. Php	Alkaline phosphatase
ALT	Alanine Aminotransferase
A:G	Albumin Globulin ratio
BUN	Blood Urea Nitrogen
%	Percentage
g/dl	Grams per deciliter
µl	Microliter

Appendix 6.

Results of contrast radiography of dogs recruited into the prospective study of urinary conditions of dogs in Nairobi.

Case Number	Opacification Nep	Opacification Pye	Length L2	Length kidneys L	Length kidneys R	Width kidney L	Width kidney R	Other comments
01	Fair	Poor	3.5	10.5	10.8	4	4.2	Renal pelvis of the left kidney had discrete radiopaque areas.
02	Poor	Good	3	7	6.8	4.5	4.3	
03	Good	Poor	3	7.3	7.5	3.5	3.8	-The bladder was severely distended and had many small radiopaque areas within it. -On the pyelogram the ureters were visible but not the renal pelvis and the pelvic recesses. -On the lateral view at 40min an enlarged prostate was seen at the pelvic inlet. -The nephrogram was still the same at 40min.
05	Poor	Fair	3.3	8.8	9.2	5.4	5	

Appendix 6 continued

06	Good	Fair	3.1	8.9	9.4	5 4.5	Proximal ureters (both) were dilated =0.5cm Left kidney was larger than the right one. 20 minute nephrogram of the right kidney was fading but that of the left kidney was still the same.
07	Fair	Poor	2.8	8.6	7.6	4.8 4.8	Left ureter was dilated to 0.4cm The urinary bladder wall was thickened at craniodorsal and cranioventral borders. Nephrogram was fading well.
08	No opacification of nephrogram or pyelogram.						
09	Poor	Fair	3.2	8.9	8.5	3.7 5.2	Renal pelvis of left kidney was dilated = 0.5cm
10	Good	Fair	2.4	6.7	6.3	4.2 3.8	Renal pelvis and ureters were opacified but not the pelvic recesses. At 40 minutes the nephrogram was fading

Appendix 6 continued

11	Good	Fair	2.3	6.6	6.7	3.2 3.4	At 0 and 5 minutes only the ureters were opacified. At 20 minutes the pyelogram of left kidney was good, that of the right kidney was not visible.
12	Good	Fair	3	8.2	8	4.7 4.3	Left and right kidney were at the same level. Left renal pelvis was dilated = 0.4cm
13	Fair	Poor	3.4	9.8	9.7	6.7 5.6	Right ureter was dilated. Pyelogram opacification was poor.
14	Good	Fair	2.9	8.5	8.2	4.4 4.6	Both ureters were dilated = 0.4cm. Only the ureters and renal pelvis were opacified in the pyelogram.
15	Good	Fair	2.9	8.3	8.4	4.8 5	By 20th minute nephrogram was fading and pyelogram was becoming better

Appendix 6 continued

16	Fair	Good	2.8	8.6	8.5	5 4.6	Renal pelvis of left kidney was dilated = 1.5cm, while it was slightly dilated on the right side to about 0.5cm. Nephrogram was faded by 40min
17	Poor	Fair	2.5	7.4	7.4	4.2 4.4	
18	Fair	Good	3	8	8.3	4.8 4.8	Left kidney had varying opacification of the renal parenchyma. Both nephrogram and pyelogram of left kidney were fading by 40 minutes
19	Fair	poor	2.2	6.4	6.6	3.6 3.8	
20	Good	Fair	3	9.2	8.9	5.2 4.6	Proximal ureter of left kidney was dilated =0.5cm. Left kidney had varying opacification
21	Poor	Fair	3.8	9	8.5	4.4 5.1	Both nephrogram and pyelogram were fading by the 40^{th} minute.
22	Fair	Poor	2.6	7	6.7	3.4 3.2	Renal pelvis of right kidney was slightly dilated
23	Good	Fair	3.4	8.9	9.1	4.1 4.6	

Appendix 6 continued

24	Good	Good	2.2	10	10.2	4.8 5.2	Distended urinary bladder at 40 minutes. both pyelogram and nephrogram were good
25	Poor	Fair	3	7.6	7.4	3.8 3.4	
26	Fair	Good	3.6	7.8	8.2	4 4.3	
27	Poor	Fair	2.8	9	9.2	4.4 4.6	
28	Fair	Poor	2.4	9.4	9.8	4.6 5.0	
29	Good	Fair	3.2	7.2	7.6	3.6 3.8	
30	Poor	fair	2.7	6.8	7.2	3.2 3.8	

KEY: Nep – Nephrogram Pye – Pyelogram L2 – Lumbar Vertebrae 2 L – Left R - Right