EVALUATION OF THE URINARY TRACTS OF NIGERIAN INDIGENOUS DOGS BY PHYSICAL EXAMINATION, ROUTINE URINALYSIS AND URINE CULTURE

BY

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DECLARATION

The work presented in this thesis is original and carried out under the supervision of Professors S. U. Abdullahi and K. A. N. Esievo and Dr. J. O. Adekeye in the Small Animal Clinic of the Veterinary Teaching Hospital and the laboratories of the Department of Veterinary Pathology and Microbiology, Ahmadu Bello University, Zaria.

The work of other investigators was referred to and acknowledged. No part of this thesis has previously been submitted for a degree or a diploma.

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CERTIFICATION

This thesis entitled "Evaluation of the Urinary tracts of Nigerian indigenous dogs by physical examination, routine urinalysis and urine culture" by Yusuf M. Abubakar meets the regulations governing the award of the degree of Master of Science of the Ahmadu Bello University, Zaria and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This work is dedicated to the
entire members of the Mallam Bukar Marte
family and the memory of my late dear ones.

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ABSTRACT

The urinary tracts (UTs) of 200 Nigerian indigenous dogs (NIDs) brought to the Ahmadu Bello University Veterinary Teaching Hospital, Zaria during a 9-month period were evaluated by physical and urine examinations and the normal values of some urine parameters determined. The ages of the dogs ranged from 1½ months to 11½ years.

On physical examination, only one dog was found to have an abnormality of the UT; it had a thickened bladder wall and an enlarged prostate gland.

Routine urinalysis revealed low urine specific gravity (5 dogs), proteinuria (31 dogs), glucosuria (2 dogs), ketonuria (1 dog), epithelial cells (34 dogs), casts (46 dogs) neoplastic cells (1 dog) and the larvae of Dirofilaria repens (1 dog). Crystalluria was observed in 37 dogs consisting of struvite (20 dogs), ammunium acid urate (7 dogs), calcium oxalate (4 dogs), cystine (1 dog), uric acid (1 dog) and mixed (4 dogs) crystals. Also, 23 dogs had spermatozoa in their urine sediments.

Urine culture studies showed the bacteria isolated to be Escherichia coli (9 dogs), Staphylococcus aureus (7 dogs), Staphylococcus epidermidis (4 dogs), Corynebacterium renale (3 dogs), Pseudomonas aeruginosa (1 dog), Proteus mirabilis (1 dog),

Enterobacter spp. (1 dog), Salmonella arizona (1 dog) and Pasteurella aerogenes (1 dog). However, none of the dogs had clinical urinary tract infection.

Ranges of specific gravity and pH of urine samples from normal dogs were determined as 1.005 - 1.030 and 5.0 - 8.5 respectively while their means and standard deviations, 1.015 ± 0.01 and 6.99 ± 0.79 respectively, represent normal urine parameters. The ages and the sex of the animal had no effect on these values.

The results of this study indicate very low incidence of clinical UT problems in NIDs as suspected by earlier researchers in Nigeria. However, certain subclinical abnormalities may exist in the NIDs as suggested by the results of this study.

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Chapter 1

URINARY TRACT PROBLEMS IN DOGS: A REVIEW OF THE LITERATURE

1.1 Introduction

The urinary system comprises of the kidneys, the ureters, the bladder and the urethra. The kidneys are commonly described as excretory organs, but the assignment of such a limited role scarcely does them justice. They are primarily organs which regulate volume and composition of the internal fluid environment. They play a prominent role in concentration of metabolic wastes, and the control of osmotic pressure, fluid volume and ionic composition of our internal fluid environment (Pitts, 1976). The kidneys also play a role in the elaboration of hormones involved in haematopoiesis and sodium reabsorption as well as activation of vitamin D to its active form (Bovee, 1984a).

Urinary tract (UT) diseases have been well documented in the developed countries (Osborne et al., 1972; Ettinger, 1975; Bovee, 1984b) as renal failure (Osborne et al., 1972; Osborne et al., 1975; Finco and Barsanti, 1976; Cowgill, 1984), urinary tract infections (Finco and Barsanti, 1979; Ling et al., 1979; Osborne et al., 1979), urolithiasis (Goulden, 1968; Finco et al.,

1970; Weaver, 1975; Clarke, 1974a, 1974b; Brodey, 1955), congenital abnormalities (Osborne et al., 1972) and neoplasia (Drew et al., 1972; Baskin and Paoli, 1977; Goldschmidt, 1984) have all been reported. Other reported problems of the urinary tracts of dogs include urethritis, cystitis and ureteritis (Polzin and Jeraj, 1979), urinary incontinence (Holt, 1983; DiBartola and Adams, 1983) and parasitic infections (Senior, 1980; Gillespie, 1983). In Nigeria, canine UT diseases have been reported to be uncommon (Idowu et al., 1983; Abdullahi et al., 1984a; Abdullahi et al., 1985). The few reported cases are urolithiasis (Idowu et al., 1983; Abdullahi et al., 1985; Abdullahi and Adeyanju, 1987), renal failure and neoplasia (Abdullahi et al., 1985) and urinary incontinence (Abdullahi and Amber, 1986). It is obvious that diseases of the UTs of dogs, particularly urinary tract infections (UTIs), are more common in developed countries than in Nigeria. The reason for this difference is not apparent. Abdullahi et al. (1984a) theorized that freedom of Nigerian indigenous dogs (NIDs) to urinate at will is probably responsible for the low incidence of UTI as urine stasis, a predisposing factor for UTI (Osborne et al., 1979), is unlikely to be common in the NIDs. Urine pH and osmolality of dogs are known to influence bacterial multiplication in urine

and therefore prevent or predispose dogs to UTI (Lees et al., 1979a). Thus, extreme values of urine pH (i.e high or low) prevent bacterial growth while moderate values promote growth. Similarly, high osmolality values of urine prevent bacterial growth in urine (Lees and Osborne, 1979). Urinary tract infection is uncommon in cats because they produce urine with high osmolality value (Lees et al., 1979b). The urine pH and osmolality values of NILs have been shown to be similar to those of dogs in developed countries (Hammen et al., 1991).

1.2 Renal failure

The term renal failure describes a level of organ function rather than a disease entity (Osborne et al., 1972). It is significant to differentiate renal failure from renal disease. Renal disease refers to the presence of renal lesions of any size, distribution, or cause which may or may not cause renal failure. On the other hand, renal failure implies that three-quarters or more of the functional capacity of the nephrons of both kidneys have been eliminated (Osborne et al., 1975). Renal failure can be acute or chronic with the signs being more similar than dissimilar (Osborne et al., 1972).

a) Acute renal failure is a clinical state characterized by oliguria and/or anuria, reduced renal blood flow and glomerular filtration

rate (GFR) and the biochemical consequences associated with these changes (Cowgill, 1984).

b) On the other hand, chronic renal failure is characterized by polydypsia/polyuria. "rubber jaw" and anaemia (Michell, 1983).

In dogs, the aetiologies of renal failure can be broadly categorized into haemodynamically-mediated, nephrotoxic and miscellaneous causes. The causes of haemodynamically-mediated acute renal failure include all those factors predisposing to pre-renal azotemia. However, in the former hypoperfusion is so intense and profound that it cannot readily be reversed (Cowgill, 1984). The spectrum of toxins causing acute renal failure are so extensive and includes a variety of heavy metals, organic compounds, solvents, antimicrobials, miscellaneous drugs and endogenous solutes (Porter and Bennett, 1981; Thornhill, 1980). Ethylene glycol and diethylene glycol are common organic nephrotoxins found as components of lacquers, cosmetics and flavouring extracts. Oxalic acid, a major metabolic product of ethylene glycol is considered the primary toxic intermediate. Oxalic acid readily produces necrosis of epithelial cells and intratubular obstructions subsequent to calcium oxalate crystal deposition (Porter and Bennett, 1981; Thornhill, 1980). The antimicrobials cause acute renal failure via any

or a combination of the following: hypersensitivity or anaphylactic reaction or immune-mediated glomerular damage; disruption of cellular function thereby causing cellular death; impairment of glomerular ultrafiltration; tubular obstructions because of the precipitates they form and induction of epithelial necrosis (Cowgill, 1984).

Only a few cases of renal failure have been reported in Nigeria. There were two reported cases of renal failure in Zaria. These include a twelve-year-old male NDL presented to the Ahmadu Bello University Veterinary Teaching Hospital (ABUVTH) because of polydypsia, polyuria and anorexia while the other was encountered at necropsy (Abdullahi et al., 1989).

1.3 Urinary Tract Infections

Urinary tract infection encompasses a wide variety of clinical entities whose common denominator is the microbial invasion of any of its components (Osborne et al., 1979). Infection may predominate at a single site such as the kidneys (pyelonephritis), ureter (ureteritis), bladder (cystitis), urethra (urethritis), or prostate gland (prostatitis), at two or more of these sites or it may be restricted to the urine (bacteriuria). In dogs, resident

bacteria of the genitourinary tract include staphylococci, streptococci, Corynebacterium spp, Escherichia coli, Acinetobacter epidermis, Pasteurella spp, Proteus spp, Klebsiella spp, Haemophillus spp and others (Carter et al., 1978), to mention a few. In a study in which bladder urine was collected by antepubic cystocentesis, approximately 25 per cent of all dogs with urinary infection had bacterial counts of less than 10^4 per ml in their urine (Ling, 1976). Therefore, bacteriuria occasionally may be present despite the finding of either negative bacterial scan or a normal white blood cell count in the urine sediment. Increased number of white blood cells (25 per hdf) and/or the presence of bacteria in the sediment were found to correlate with positive bacterial cultures in 92.4% of 230 urine specimens collected by cystocentesis (Ling, 1976).

In the U.S.A., E. coli, Staphylococcus aureus, Proteus mirabilis, Streptococcus spp, Klebsiella pneumoniae and Pseudomonas aeruginosa are the most common bacteria associated with UTI in the dog (Wooley and Blue, 1976; Ling et al., 1979). Ling et al., (1979) reported that 18% of the dogs presented to their hospital with UTI were simultaneously infected with more than one bacterial species. Staphylococcus aureus has been reported to be more commonly associated

with phosphate urolithiasis than any other bacteria (Goulden, 1968). Kivisto et al. (1977) reported that E. coli was found to be the most common bacterium associated with canine bacteriuria in Finland.

Although common bacteria are more involved in UTI of dogs, mycoplasmas such as Mycoplasma canis have also been known to cause nephritis and cystitis (Rosendal, 1982). Viruses have been isolated from the urine and UT tissues of dogs but their role in causing UTI is not clearly elucidated (Fabrieant, 1979).

In Nigeria, Addo et al. (1980) reported the causes of bacteriuria in NIDs to be Streptococcus spp, E. coli, Lactobacillus spp, Staphylococcus spp, Corynebacterium renale, Proteus spp, and Pseudomonas aeruginosa. However, some of the urine samples were collected by voluntary voiding and quantitative urine bacterial cultures were not performed; no clinical evidence of UTI was observed in any of the dogs. Abdullahi et al. (1984a) reported the isolation of bacteria in two consecutive urine samples of 7 out of 100 (7%) clinically normal dogs. The bacteria isolated were E. coli (4 dogs), Staphylococcus aureus (2 dogs) and Klebsiella pneumoniae (1 dog). In another study, there was a report of 4 dogs with

clinical UTI, showing signs including dysuria, haematuria and pollakiuria on clinical examination (Abdullahi et al., 1985). The aetiological agents were E. coli (3 dogs) and Klebsiella pneumoniae (in the other dog). Two of the dogs had polyuria, polydypsia and low urine specific gravity, suggesting possible kidney involvement (pyelonephritis). There was also a report of urinary incontinence associated with Klebsiella pneumoniae infection in a one-year-old spayed NID (Abdullahi and Amber, 1986). It was also reported that despite the detection of bacteriuria in NIDs, clinical UTI is uncommon in these dogs (Abdullahi et al., 1984a), possibly for the reason mentioned in 1.1 above.

1.4 Urolithiasis

Urolithiasis is a general term referring to stones (calculi or uroliths) anywhere in the UT. It should not be conceived as a single disease, but rather a sequela of one or more underlying abnormalities. Thus, urolithiasis may be conceptually defined as the formation of uroliths as a consequence of multiple and/or acquired pathophysiologic processes that result in the increased concentration of less soluble crystalloids in the urine (Osborne et al., 1986a). Uroliths are those sparingly less soluble waste products of the

urinary system that precipitate out of the urine to form crystals which get trapped in the system. They may combine with organic matrix and/or other minerals and grow to such a size that they cause or contribute to clinical signs.

The majority of uroliths are composed of a limited number of chemical components, including calcium, phosphate, oxalate, uric acid, cystine, ammonium and carbonate (Boves, 1984b). These components usually make up five major types of calculi in dogs and cats. Calcium crystallizes with phosphate and oxalate to form calcium phosphate and calcium oxalate calculi respectively. While cystine calculi are commonly seen in dogs with specific transport defects for amino acids in the renal tubules, uric acid and ammonium acid urate are seen more often in Dalmatians and dogs with hepatic and portal vascular anomalies (Kruger and Osborne, 1986). Magnesium ammonium phosphate (struvite) uroliths commonly form in urine infected with urea-splitting bacteria which promote their genesis and growth (Osborne and Klausner, 1978; Bovee, 1984b).

Uroliths are named according to their mineral composition (e.g magnesium ammonium phosphate hexahydrate, calcium oxalate monohydrate and calcium

oxalate dihydrate; also called struvite, whewellite and weddelite respectively), location in the UT (e.g renoliths, ureteroliths or cystoliths) or their shapes (e.g smooth, faceted, pyramidal, branched etc.) (Osborne and Clinton, 1986).

Several surveys have been conducted to determine the incidence of the various types of calculi (Finco et al., 1970; Brown et al., 1977). The breeds most commonly reported to have highest incidence of calculi are Dalmatian, Schnauzer, Welsh Corgi, Dachsund, Pekingese, Yorkshire Terrier, Irish Terrier, Pug, Beagle and Bulldog (Finco et al., 1970; Brown et al., 1977). Uric acid and urate uroliths are most common in the Dalmatian (Osborne et al., 1983) while struvite tends to be more common in Miniature Schnauzers (Osborne et al., 1986).

Struvite calculi are the most frequent type reported in all the surveys. This calculus which is commonly associated with bacterial infections is often termed "infection stone". All other types are referred to as "metabolic calculi". Calcium oxalate represents about 10 to 15% of all calculi as measured by crystallographic method (Bovee, 1984b). In the same report, calcium phosphate calculi are said to be rare in dogs representing less than 1% of calculi found while urate calculi represent 5 to 10% in most

of the surveys. The prevalence of cystine calculi ranges from 3.5 to 27%. This probably depends on the breeds of dogs encountered in a specific survey.

The age of dogs at the time of occurrence ranges from 3 to 7 years, with an approximate mean of 5.5 years (White, 1986; Brown et al., 1977; Clarke, 1976). Brown et al. (1977) reported the slightly younger age of occurrence of cystine calculi to be 4.8 years but the prevalence of calcium phosphate and calcium oxalate is said to be higher in older dogs. There are reports of occurrence of calculi in puppies 1 - 2 months of age, though it is very uncommon (Pearson et al., 1959; Hardy et al., 1972). However, majority of cases are encountered in dogs between 1 and 12 years of age (Osborne et al., 1986).

Sex of dogs does not seem to affect incidence of calculi, although females tend to have a higher rate of occurrence of struvite calculi than males (Brown et al., 1977; Osborne et al., 1986). Although cystinuria, a predisposing factor in cystine urolithiasis, has been reported in female dogs, cystine uroliths have been reported in male dogs only (Bovee, 1986). Similarly, approximately 70% of reported cases of all canine urate uroliths have been identified in male dogs (Kruger and Osborne, 1986).

There are a few reports of canine urolithiasis in exotic breeds present in Nigeria (Idowu et al., 1983; Abdullahi et al., 1985; Abdullahi and Adeyanju, 1987) and, to date, there is only one reported case of urotithiasis in a NTD (Abdullahi and Adeyanju, 1991). Freedom to urinate at will which prevents urine stasis and subsequent urolith formation is probably a factor in preventing urolithiasis in these dogs (Abdullahi et al., 1984b). High protein intake which also predisposes dogs to urolithiasis (Abdullahi et al., 1984b) does not exist in these dogs.

1.5 Congenital Abnormalities

Renal aplasia has been reported although the incidence is very rare (Osborne et al., 1972; Kealy, 1979). Prognosis depends on whether it is unilateral or bilateral. One kidney may be aplastic, congenitally deformed, ectopic or non-functional (Kealy, 1979). Kealy (1979) also reported congenital hydronephrosis of one kidney with hypertrophy of the other kidney.

Ectopic ureters have been occasionally reported as being the cause of urinary incontinence in females (Kealy, 1979; Faulkner et al., 1983). There have been reports of ureter opening into either the vagina, body of the uterus or into a uterine horn

(Kealy, 1979). This too, can either be unilateral or bilateral.

Small congenital diverticulae are reported in the wall of the bladder, at the site of attachment of the urachus (Kealy, 1979; Klausner et al., 1983). Kirk et al. (1975) reported the presence of diverticulae on the bladder wall, and in bitches with the ureters entering the vagina. Affected animals are incontinent and hydronephrosis usually develops. Malposition of the bladder associated with urinary incontinence has also been reported (DiBartola and Adams, 1983).

Congenital abnormalities of the urethra are extremely rare (Lealy, 1979). There has been a report by Kealy (1979) of its complete absence as well as its abnormal openings on the ventral aspect of the penis, into the rectum, vagina and perineum. These are usually evident on clinical examination.

1.6 Neoplasms

Canine UT neoplasms are diagnostic and therapeautic challenges for veterinarians. Diagnosis is often delayed because of lack of overt clinical signs or a partial response to empirical treatment (Crow, 1985). Most UT neoplasms are malignant and thus careful evaluation of the affected animal is

indicated (Osborne et al., 1972). Neoplasms of the bladder occur in dogs with a greater frequency than tumors of the other urinary tract organs. This presumably is because of the storage function of the bladder that allows for increased contact time between potential carcinogens and the urothelium (Crow, 1985).

Primary renal neoplasma are very uncommon in the dog (Goldschmidt, 1984). Renal neoplasms constitute from 0.6 to 1.7% of reported cases of neoplasms in the dog. The two most common being renal cell carcinoma (Grawitz's tumor) and embryonal nephroma (nephroblastoma) (Baskin and Paoli, 1977). Crow (1985) reported that most primary renal tumors are malignant and hence metastasize haematogenously, leading to their lodgement in other organs like the lungs, brain, liver, skin, eyes or bone.

Metastatic or secondary renal tumors usually are not evident as clinical problems until they are in advanced stage (Goldschmidt, 1984). In dogs, a variety of metastatic renal neoplasms have been reported, including haemangiosarcoma, malignant melanoma and mammary adenocarcinoma (Crow, 1985). Renal lymphosarcoma also occurs in dogs (Osborne et al., 1968; Baskin and Paoli, 1977). Benign renal adenomas are rarely reported in animals. Male dogs

have a sex predeliction for renal neoplasms (Hayes and Fraumeni, 1977), thus suggesting the likelihood of influence of sex hormones on the development and/or maintenance of tumor cells in the kidneys.

The incidence of urinary bladder neoplasia is low (Osborne et al., 1968). Burnie and Weaver (1983) reported that it represents between 0.5 to 1.0% of all canine tumors. Reports on canine bladder tumors were reviewed by Osborne et al. (1968) who tabulated 130 cases. Later, Hayes (1976) in an epidemiological study of 114 North American cases seen during 11-year period in 13 different university clinics claimed that the world literature included about 300 cases. Burnie and Weaver (1983) reported on the clinical features of 22 canine bladder carcinomas over a period of 19 years in U.K. and remarked on an apparent increase in incidence over this period. Most canine bladder neoplasms are malignant with transitional cell carcinoma being the most prevalent (Osborne et al., 1968). Other malignant tumors include squamous cell carcinomas, botryoid rhabdomyosarcomas, chemodectoma and fibrosarcoma (Crow, 1985).

Crow (1985) reported that primary ureteral and urethral tumors are very uncommon in the dog.

These include: transitional cell carcinomas, squamous cell carcinomas, and adenocarcinomas. However, most of these are thought to represent extensions from the bladder or prostate rather than primary tumors (Berzon, 1979; Tarvin et al., 1978; Wilson et al., 1979).

Information as to the incidence of UT neoplasms in Nigeria is scarce. However, there is a reported case of metastatic kidney tumor detected at necropsy, in Zaria (Abdullahi et al., 1985). This case, however, was not classified.

1.7 Summary

The literature is full of reports (but not exhaustive) on UT problems. However, most of these reports are from developed countries. Only few are from Nigeria. It is suspected that not much attention is given to problems of dogs in general and UT problems of dogs in particular in developing countries including Nigeria. It is quite possible that the diseases do exist in the dogs. The efforts made in Nigeria to study UT of dogs seem to indicate that the disease may have a low incidence. However, more extensive study is required to confirm this.

Chapter 2

EVALUATION OF THE URINARY TRACTS OF NIGERIAN INDIGENOUS DOGS BY PHYSICAL EXAMINATION, ROUTINE URINALYSIS AND URINE CULTURE

2.1 Introduction

Urinary tract (UT) problems constitute a significant percentage of the diseases encountered in dogs in developed countries such as the U.S.A. and Britain. For instance, urolithiasis was reported to have an incidence of up to 2% in all dogs receiving medical care (Finco et al., 1970; Kivisto et al., 1977) while up to 7% of all the dogs presented at a large hospital had urinary tract infection (UTI) (Ling, 1976). In contrast, there are few reports of UT problems of dogs in Nigeria (Abdullahi et al., 1985). Although this low incidence of UT problems of dogs in Nigeria may not be unconnected with the low interest of veterinarians in diseases of the urinary system, Abdullahi et al. (1985) believe that there is indeed a low incidence of such diseases, at least at the Ahmadu Bello University Veterinary Teaching Hospital (ABUVTH), Zaria. However, the study on which this assertion was made was a retrospective study of necropsy records. It is, therefore, possible that a closer evaluation of the UTs of Nigerian dogs may reveal a different picture. It is for this reason that

this study was designed and conducted with the following objectives:

1. To determine the incidence of abnormalities of the UTs of Nigerian indigenous dogs (NIDs) by physical and urine examinations; and
2. To determine normal values of some urine parameters of the NIDs.

2.2 Materials and Methods

2.2.1 Animals

Nigerian indigenous dogs (NIDs) presented to the Small Animal Clinic of the ABUVTH, Zaria between 23rd January, 1991 and 25th October, 1991 (9 months) were used for the study. All NIDs presented during the period for various reasons including routine check-up, vaccinations, elective surgery and other illnesses were physically examined for abnormalities related to the UT. Particular attention was paid to the inspection and palpation of the tract.

2.2.2 Sample Collection

All presented NIDs had their urinary bladders palpated. Urine, when available, was obtained by the technique of cystocentesis as described by Ling (1976). About 10 ml of urine was collected from each dog using sterile 22G x 1½" needle and 10 ml syringe. Samples not processed immediately were refrigerated at $4^{o}C$ until processed within 30 minutes.

2.2.3 Routine Urinalysis

Each urine sample was thoroughly mixed and 5 ml was transferred into a sterile conical tip centrifuge tube. The urine was then examined for the following using commercial strips (Multistix^{R}, Miles Limited, Ames Division, Slough, England): pH, specific gravity (SG), protein, glucose, Ketones, bilirubin, blood and urobilinogen. The same sample was centrifuged at 1,000 r.p.m for 5 minutes after which the supernatant was decanted leaving only a drop at the bottom of the centrifuge tube. A drop of New Methylene Blue stain was added to the contents of the tube using a clean Pasteur pipette. Each stained sediment was agitated to re-suspend it and the tube allowed to stand for 2 minutes after which a drop of its contents was transferred to a clean microscope glass slide and a cover slip applied. Each sediment was systematically examined using X10 and X45 objective lenses of a light microscope. The type and quantity of cells, casts, crystals, and parasites and their developmental stages were determined.

2.2.4 Urine Culture

Five millilitres of each urine sample was poured into a sterile conical tip centrifuge tube and centrifuged at 1,000 r.p.m for 5 minutes. The supernatant was decanted leaving about 1 ml in the

tube which was agitated to mix the contents. Using a sterile pipette, 0.25 ml of the content was poured into each of two Blood Agar plates and two McConkey plates. One of the Blood Agar and one of the McConkey plates were incubated aerobically at 37°C for 24 hours while the other two plates were incubated microaerophillically (using a candle jar) at 37°C for 24 hours.

At the end of the incubation period, the plates were examined for bacterial colonies. Smears from colonies were made on microscope slides and stained with Gram's stain to study their Gram reaction and morphology. Biochemical tests were carried out on subcultures to determine the genera and species of isolates, using standard procedure (Cowan, 1974).

2.2.5 Determination of Normal Urine Parameters

Data from 90 apparently healthy NIDs that had no detectable abnormal urine specific gravity and pH values and other abnormalities of the UT was used to determine normal values.

2.3 Results

2.3.1 Physical Examination

One hundred and sixty-seven out of 200 (83.5%) of the dogs examined in the study were 2 years old or younger. A total of 547 NIDs were physically examined for abnormalities associated with the urinary tract (UT).

Only one dog had such an abnormality. This dog was a 7-year-old male having thickened urinary bladder wall and an enlarged prostate as determined by abdominal and rectal palpations respectively. Urine sediment examination revealed numerous transitional epithelial cells with several mitotic figures highly suggestive of transitional cell carcinoma.

2.3.2 Routine Urinalysis

Urine samples were obtained from 200 NIDs (118 males and 82 females) during the period of the study. The ages of the dogs ranged from 1½ months to 11½ years. Table 2.1 shows the results of urinalysis and revealed the following abnormalities: low specific gravity (lower than glomerular filtrate, 1.001) (5 dogs); proteinuria (31 dogs); glucosuria (2 dogs); ketonuria (1 dog); bilirubinuria (16 dogs); high urobilinogen (5 dogs); haematuria (28 dogs); pyuria (59 dogs); high number of epithelial cells (34 dogs); high number of casts (46 dogs); neoplastic cells (1 dog) and helminth larvae (1 dog).

The 5 dogs with low urine specific gravity were all young. Each had a urine pH of 8.5, with only one of them having a detectable abnormality of the UT (small amount of glucose in its urine, 14 mmol/l). Of the dogs with proteinuria, only two had appreciable quantities of protein (++, 1g/l). Both dogs were 3

Table 2.1: Abnormal Findings in the Urine of 200 Nigerian Indigenous Dogs Presented to the ABUVTH*

Abnormality	Number of Dogs		
	Males	Female	Total
Low specific gravity (1.00)	1	4	5
Proteinuria	19	12	31
Glucosuria	1	1	2
Ketonuria	1	-	1
High bilirubin	6	10	16
High urobilinogen	4	1	5
Haematuria	19	9	28
Pyuria	39	20	59**
Increased number of epithelial cells	20	14	34
Neoplastic epithelial cells	1	-	1
Increased number of casts	27	19	46
Helminth larva (Microfilaria)	1	-	1

*ABUVTH = Ahmadu Bello University Veterinary Teaching Hospital, Zaria.

**25 dogs (10 males and 15 females) also had bacteriuria.

months old, had high urine specific gravity and no evidence of infection. Although both dogs with glucosuria had low concentration of glucose in their urine (+, 14 mmol/l), one of them had low urine specific gravity (1.000). The only dog with ketonuria had only small quantities of ketone bodies (+, 1.5 mmol/l) and had no other abnormality; its urine specific gravity was 1.030. Seven of the dogs with large amounts (+++) of bilirubin in their urine had clinical babesiosis due to Babesia canis as confirmed by blood examination. Similarly, all the 5 dogs with higher than normal values (1.6 - 16 mmol/l) of urobilinogen had confirmed B. canis infection.

One of the dogs with severe haematuria (+++) had bacteriuria due to Staphylococcus aureus as well as pyuria while another haematuric dog had larvae (microfilariae) of Dirofilaria repens in its urine. Twenty five of the pyuric dogs had bacteriuria also. The dog with the thickened urinary bladder wall was also pyuric. Fifteen dogs with high numbers of epithelial cells in their urine sediments also had high numbers of casts.

Table 2.2 shows the incidence of crystalluria in urine of the 200 NIDs examined in this study. Thirty-seven dogs (18.5%) had crystalluria with struvite crystals (20 dogs; 10%) being the most common form

of crystal. Other less frequent crystal types included ammonium acid urate (7 dogs; 3.5%), calcium oxalate (4 dogs; 2%), cystine (1 dog; 0.5%) and uric acid (1 dog; 0.5%). Four dogs had two crystal types each. The incidence of struvite crystals is essentially the same in both sexes. On the other hand, ammonium acid urate crystals were more common in females (6 dogs; 3%) than in males (1 dog; 0.5%) while calcium oxalate crystals were more commonly encountered in males (3 dogs; 1.5%) than in females (1 dog; 0.5%). Dogs with struvite crystals had the highest mean urine pH (7.3). No association between the incidence of struvite crystals and the incidence of bacteriuria due to urease-producing bacteria could be established.

Twenty-three male dogs had spermatozoa in their urine sediments.

2.3.3 Urine Culture

Table 2.3 shows the incidence of bacterial isolation from the urine of the NIDs. A total of 27 dogs (13.5%) had bacteriuria. It was also found out that all the bacteria isolated microaerophillically were isolated aerobically as well following 24 hr of incubation at 37°C. Two of the dogs had more than one bacterial species in their urine. The most commonly isolated bacteria were Escherichia coli and

Table 2.2: Incidence of Crystalluria in 200 Nigerian Indigenous Dogs Presented to the ABUVTH*

Crystal Type	Number of Dogs			
	Males	Females	Total	Urine pH ($\bar{X} \pm SD$)
Struvite	11	9	20	7.3 ± 0.84
Ammonium acid urate	1	6	7	7.0 ± 1.07
Calcium oxalate	3	1	4	6.6 ± 0.65
Cystine	1	-	1	7.0
Uric acid	1	-	1	6.0
Mixed**	2	2	4	7.0 ± 0.25
Total	19	18	37	6.8 ± 0.95

*ABUVTH = Ahmadu Bello University Veterinary Teaching Hospital, Zaria.

**(2 dogs had struvite and calcium oxalate, calcium oxalate and cystine, and struvite and ammonium acid urate seen in one dog each).

Table 2.3: Incidence of Bacteriuria in 200 Nigerian Indigenous Dogs Presented to the ABUVTH*

Bacterial sp.	Number of dogs**			
	Males	Females	Total	Urine pH
Escherichia coli	6	3	9	7.5 ± 0.94
Staphylococcus aureus	5	2	7	6.9 ± 0.99
Staphylococcus epidermidis	4	-	4	7.0 ± 0.91
Corynebacterium renale	1	2	3	7.5 ± 1.32
Pseudomonas aeruginosa	-	1	1	8.0
Proteus mirabilis	-	1	1	8.0
Enterobacter species	-	1	1	6.5
Salmonella arizona	1	-	1	7.0
Pasteurella aerogenes	1	-	1	7.0

*ABUVTH = Ahmadu Bello University Veterinary Teaching Hospital, Zaria.

**1 dog had two bacterial species and one other dog had three.

Staphylococcus spp. Most bacteriuric dogs had alkine urine pH. Fifteen of the bacteriuric dogs (55.6%) had pyuria, 5 dogs (18.5%) had high number of casts and 4 dogs (14.8%) had haematuria. Eight bacteriuric dogs had crystalluria but there was no association between the incidence of a particular bacterial species and the occurrence of any particular crystal type.

2.3.4 Determination of Normal Urine Parameters

Table 2.4 shows the normal values of specific gravity and pH. Age did not seem to have any effect on the values. The overall mean and standard deviations of the specific gravity and pH were 1.015 ± 0.01 and 6.99 ± 0.79 respectively while the ranges were 1.005 - 1.030 and 5.0 - 8.5 respectively.

2.4 Discussion

The observation of low incidence of UT problems in NIDs in this study agrees with earlier reports (Addo et al., 1980; Abdullahi et al., 1984a; Abdullahi et al., 1985; Abdullahi and Adeyanju, 1991). This observation is in contrast with observations in developed countries where UT problems are common (Osborne et al., 1972; Bovee, 1984b). The reason for this difference is not apparent. Abdullahi et al., (1984a) have suggested that freedom of NIDs to urinate at will may, at least in part, be responsible,

Table 2.4: Urine Specific Gravity and pH Values of 90 Normal Nigerian Indigenous Dogs Presented to the ABUVTH*

Age Group (months)	Number of dogs	Specific Gravity** ($\bar{X} \pm SD$)	pH*** ($\bar{X} \pm SD$)
1 - 6	41	1.017 ± 0.01	6.83 ± 0.78
7 - 12	23	1.015 ± 0.01	7.04 ± 0.81
13 - 18	7	1.013 ± 0.01	7.21 ± 0.81
19 - 24	7	1.012 ± 0.01	7.37 ± 0.61
25 - 30	1	1.010	8.00
31 - 36	3	1.013 ± 0.01	7.17 ± 0.76
36	8	1.019 ± 0.01	6.88 ± 0.58
Total	90	1.015 ± 0.01	6.99 ± 0.79

*ABUVTH = Ahmadu Bello University Veterinary Teaching Hospital, Zaria.

**Reported normal range for adult exotic breeds is 1.015 - 1.045 (Osborne and Stevens, 1981).

***Reported normal range for adult exotic breeds is 4.5 - 8.5 (Osborne and Stevens, 1981)

particularly for UTI and urolithiasis. Other possible reason for the lower incidence in NIDs is consumption of low protein diet, particularly for urolithiasis. It is also quite possible that dogs with serious UT diseases die before they are presented at the ABUVTH.

The presence of moderate proteinuria (+, 300 mg/l) in 29 dogs could be attributed to exercise or febrile proteinuria (Osborne and Stevens, 1981) as most of the dogs were walked to the clinic. Moreover, some of the proteinuric dogs had haematuria which is commonly associated with proteinuria. The high protein (++, 1 g/l) in urine of two dogs suggests renal dysfunction (Osborne et al., 1972). As casts were not seen in high numbers and UTI was absent, it is logical to suspect glomerular abnormality (Jergens, 1987).

The glucosuria (1 dog) and ketonuria (1 dog) observed in this study might have been physiologic in nature as no other abnormalities of the UT were observed in the affected dogs (Osborne and Stevens, 1981). Physiologic glucosuria which is usually transient, is said to be associated with the release of endogenous epinephrine and glucocorticoids and is thought to be dependent on mobilization of glycogen stored in the liver (Osborne and Stevens, 1981). The

high amount of glucose in urine of one other dog is considered to be of renal origin although the cause could not be determined; however, high number of casts indicative of renal disease (Osborne and Stevens, 1981) were not observed in the urine of this dog. Diabetis mellitus might have accounted for, at least in part, to the observed glucosuria and ketonuria in these dogs, but this was not studied in the dogs.

High levels of bilirubin and urobilinogen in urine of dogs are commonly associated with hepatic disease or severe haemolytic crises. It is believed that all the high levels of bilirubin and urobilinogen encountered in the urine of dogs in this study were due to B. canis infection (Coles, 1986) which is very common in Zaria area (Trimnell et al., 1985).

The microscopic haematuria detected in 28 dogs is probably of little significance except in one dog that exhibited signs of dysuria in the mornings and also had microfilariae (of D. repens) in its urine.

The incidence of pyuria in this study was found to be 29.5% (59 dogs). This value was about twice that of a previous finding of 16% by Abdullahi et al. (1984a). Occasional observation of WBCs/hdf was reported (Osborne et al., 1972) in the urine of normal patients. The concurrent observation of pyuria and bacteriuria in 25 (42.37%) of the dogs also agrees with an earlier finding by Abdullahi et al. (1984a) in which 5 out of 16 dogs

(31.42%) with pyuria had bacteriuria as well. The pyuria seen in the remaining 44 dogs (74.58%) might be due to other inflammatory processes in the UT as earlier reported by Osborne and Stevens (1981).

Different typies of epithelial cells originating from the various portions of the urogenital tract have been reported by Osborne and Stevens (1981) to be commonly found in the urine of normal dogs and cats. Our observation of epithelial cells in 3% or the dogs (17%) is similar to an earlier finding of 19% by Abdullahi et al. (1984a). Epithelial cells are found in the urine as result of attrition and exfoliation (Osborne and Stevens, 1981).

Our finding of increased number of casts in the urine sediments of 46 dogs (23%) in this study is slightly unusual. However, occasional occurrence of a few hyaline or granular casts (Less than approximately 1- 2/low power field in moderately concentrated urine) in the sediments of otherwise normal patients is not a reliable index of significant renal damage (Osborne and Stevens, 1981). In the same report, it was however, stated that absence of casts does not rule out renal tubular disease. The high incidence of casts observed in this study does not seem to agree with an earlier one by Abdullahi et al. (1984a) in which casts were seen in urine sediments of only 6 (6%) out of 100 dogs. The reason for this not apparent but may be as result

of the physiologic proteinuria observed in some (31) of the dogs in this study; casts are proteinaceous in nature and may be eliminated in the urine immediately after formation (Osborne *et al.*, 1972; Osborne and Stevens, 1981).

The microfilariae of the helminth *D. repens* observed in the urine of a dog in this study has not been previously reported in Nigeria. The microfilariae of *D. repens* are known to reside in the subcutaneous tissues of dogs and cats and exhibit arratic migration (Schillhorn, 1974; Mohan, 1976). As such it is not surprising to find them in the glomerular capillaries. Mohan (1976) reported that changes in the kidneys like infarcts, capsular haemorrhages and interstitial necrossis were associated with the toxins the parasites produce. The only evidence of helminth infection in the UT of dogs in Nigeria was a report or detection of *Capillaria plica* eggs in urine of one dog (Abdullahi *et al.*, 1984a).

The observation of crystalluria in 37 (18.5%) the evaluated dogs in this study is lower than an earlier report of 38% incidence (approximately twice as much) by Abdullahi *et al.* (1984a). The finding that struvite crystals were the commonest encountered (representing 54.1% of the total) agrees with a finding in the above work. Among the crystals observed in this study, only ammonium acid urate, uric acid and cystine may be of

of the urogenital tract of dogs. The relatively higher isolation rates of E. coli and staphylococci in this study as compared to the other bacteria is also similar to other previous reports in Nigeria (Abdullahi et al., 1984a; Abdullahi et al., 1985), the U.S (Wooley and Blue, 1976; Ling et al., 1979) and Finland (Kivisto et al., 1977). However, Addo et al. (1980) reported fewer isolates of E. coli relative to staphylococci. The detection of mixed infections in two of the dogs is also similar to a finding by Addo et al. (1980) in the above in which 10 out of 25 bacteriuric dogs without clinical UTI were found to have mixed infections. The incidence of bacteriuria (13.5%) in this study is much higher than the 7% reported by Abdullahi et al. (1984a). This is probably due to culture of the urine sediment rather than direct urine culture employed in the latter study. In contrast, Addo et al. (1980) reported a much higher incidence of 24%. The reason for this is not apparent but might be as a result of the longer incubation period (72 hours) employed in their work.

The specific gravity and P^H values in normal dogs encountered in this study are similar to those reported elsewhere (Osborne and Stevens, 1981). Similar observation had been made in respect of urine pH and osmolality values of NIDs (Mamman et al., 1991). The normal values of specific gravity and pH of NIDs reported in this study are believed to be the first documentation of the values.

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