HEPATO - RENAL PATHOLOGY IN CANINES

By
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THESIS

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DECLARATION

I hereby declare that the thesis entitled **"HEPATO-RENAL PATHOLOGY IN CANINES"** is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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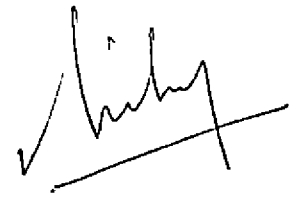
Certified that this thesis, entitled **"HEPATO-RENAL PATHOLOGY IN CANINES "** is a record of research work done independently by **Ms. R. Lakshmi**, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, associateship or fellowship to her.



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R. Lakshmi

DEDICATED TO

MY PARENTS

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INTRODUCTION

1. INTRODUCTION

Liver and kidney are important organs of the body, performing diverse functions. Because of the complexity in structural organisation and diversity in functional activities of both these organs, the spectrum of malfunctions to which they fall victim is complex.

The functions of the liver are secretory, haemopoietic, metabolic, defensive and excretory. Liver is concerned with the secretion of bile and is the site of erythropoiesis in foetal life. It is the primary organ concerned with carbohydrate, protein and fat metabolism. Kupffer cells of the liver form a defensive line against harmful microbial invaders. Yet another vital function of the liver is detoxification of toxins and excess hormones. The vital homeostatic functions performed by the kidney include excretion of waste products, maintenance of normal concentration of salt and water in the body, regulation of acid base balance and the production of a variety of hormones.

The natural inquisitiveness of dogs often exposes them unnecessarily to toxic substances. The liver and the kidney are the frequent targets of these toxic chemicals. Both these organs help in metabolism, detoxification and excretion of foreign substances and

thus are frequently involved in poisonings. It is estimated that approximately 25 per cent of all poisonings affect the liver. The liver normally receives 100 per cent of portal venous blood, 28 per cent of cardiac output and therefore, any poison absorbed from the gastrointestinal tract goes through the liver first. Although the kidneys constitute less than one per cent of body weight, they receive 25 per cent of the total cardiac output. This explains the high renal exposure to xenobiotics. Toxic induced acute renal failure is a commonly encountered problem in dogs.

The liver and kidney are also affected in many bacterial and viral diseases. They are the primary target organs in zoonotic diseases like Leptospirosis. Some parasitic diseases also affect the liver and kidney.

The high degree of specialization of the cells of these organs make them vulnerable even to apparently mild irritants. The clinical silence following injury is largely attributable to a high degree of reserve functional capacity and a complex and multiple activity of the liver and kidney, in addition to the unusual ability of the liver to regenerate.

It is pertinent to point out that the symptomatology in liver and kidney disorders are vague, lacking specificity and therefore are bound to miss the attention of the clinician even though they may exist. Failing liver or kidney function may cause dysfunction of other organs. Also, these organs may be secondarily affected as a result of diseases in other organ systems. Considering the significance of these two organs, an in-depth study on the various pathological disorders affecting them was undertaken with the following objectives.

1. To study the prevalence of liver and kidney disorders in canines.

2. To classify the lesions encountered in these organs age-wise, sex-wise and breed-wise.

3. To classify the different types of lesions encountered in these organs into various categories.

4. To correlate the lesions between these organs and with the gross lesions in other organs.

5. To provide an awareness among clinicians on common disorders affecting these organs and to choose suitable preventive and curative measures.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

2.1. Liver

2. 1.1. Prevalence

Postmortem examinations carried out in 12,245 dogs by Patnaik *et al.* (1980) revealed the presence of 110 primary liver neoplasms. These included 55 hepatocellular carcinomas, 24 bile duct carcinomas, two concomitant hepatocellular and cholangiocellular carcinomas, 15 carcinoids and 14 sarcomas. Hepatocellular carcinoma and sarcoma occurred more often in the males, where as bile duct carcinoma was common in the females. Average age of occurrence was above 10 years.

Hayes *et al.* (1983) identified 77 cases of bile duct carcinoma among 1.1 million autopsies in dogs. A possible association of this condition with canine hook worm and whip worm infections was suggested by them.

Of the 951 dogs autopsied by George *et al.*(1986), 4.3 per cent were jaundiced, out of which 55 per cent of the cases were obstructive, 16 per cent toxic and 28 per cent haemolytic. Involvement of *Babesia canis*, *Hepatozoon canis* and *Ehrlichia canis* were identified.

Thornburg (1988) examined 1800 dogs with liver disease for a period of seven years, and attributed 42 cases to the toxic effects of drugs including methoxyflurane, halothane, trimethoprim, mebendazole and anticonvulsants.

Anderson and Sevelius (1991) studied the breed, sex and age distribution in dogs with chronic liver disease. They observed that, males were commonly affected among Spaniels and the average age of the incidence was five years. Among Labrador Retrievers, females were mostly affected and the average age of incidence was seven years.

Infectious causes of hepatic diseases in dogs as observed by Johnson (2000) included Infectious canine hepatitis, acute bacterial cholangio hepatitis, Leptospirosis, liver abscesses, systemic mycoses, Toxoplasmosis and heartworm disease.

2.1.2. Developmental anomalies

Smith *et al.*(1972) reported the occurrence of congenital hepatic cysts in dogs. The cysts were of varying sizes and were lined by cuboidal epithelium.

Lesions in congenital hepatic arteriovenous fistulae in dogs were described by Moore and Whiting

(1986) and Schermerhorn *et al.*(1997). Marked bile duct proliferation, hepatic parenchymal atrophy and dilation of arterial branches with collapse of the veins were seen throughout the liver.

Schermerhorn *et al.* (1996) described the congenital disorder, Microvascular dysplasia (MVD) of hepatic vasculature in Cairn terrier dogs. Contrast photography revealed abnormalities of terminal twigs of the portal vasculature.

Mc Aloose *et al.* (1998) reported Polycystic liver disease in terriers. The cysts were of biliary origin and they suggested an autosomal recessive mode of inheritance.

2.1.3. Degeneration and necrosis

Fabry *et al.* (1982), Bergman (1985), Rutgers (1996) and King (1997) reported the lesions in nodular hyperplasia of the liver in dogs, which included distorsion of normal lobular architecture, vacuolation of hepatocytes and proliferation of cells.

Linde-Sipman and Ingh (1990) conducted studies on heptic steatosis in dogs and found that livers in such cases were enlarged and pale yellow, and showed microvesicular vacuolation.

Lesions in hepatic atrophy was described by Kelly (1993) and King (1996). Small hepatocytes with scant cytoplasm were seen, with occasional inflammatory cells.

Massive hepatic necrosis with multifocal cirrhosis was reported in a Dalmatian with toxic copper levels (Napier, 1996).

Vegad and Katiyar (1998) classified hepatic necrosis as random, zonal and massive types. Random hepatocellular degeneration was characterised by single cell necrosis, whereas zonal necrosis was seen in centrilobular, midzonal or periportal areas. Massive necrosis involved complete necrosis of an entire lobule.

2.1.4. Inflammatory conditions

Chronic active hepatic disease in dogs was studied by Strombeck *et al.* (1976); Crawford *et al.* (1985); Rutgers and Haywood (1988) and Thornburg (1998). Grossly, livers were smaller, brownish red and nodular. Microscopically, livers had piecemeal necrosis, inflammatory cell infiltrates and fibrosis with disruption of terminal plates. The etiology was unknown. The potential causes suggested were hepatic

copper accumulation, drugs, infection and immune mediated diseases.

Obwolo and French (1988) observed diffuse nodular lesions on the surface of the liver of two dogs with cirrhosis. Histologically, diffuse fibrosis and fatty change were noted.

Fungal infections appeared to be the most common cause of granulomatous hepatitis in dogs (Chapman *et al.*, 1993). The lesions were characterised by infiltration with macrophages and few lymphocytes, eosinophils, plasma cells and neutrophils.

Lesions in sub-clinical Doberman hepatitis (DH) was investigated by Speeti (1998) and Speeti *et al.* (1998). The important findings were expansion of the portal areas, increased periportal and bridging necrosis, fibrosis and proliferation of the bile ducts.

Lobular dissecting hepatitis was characterised by small liver with granular surface. Histologically, bands of collagen and reticular fibres were seen between lobules with areas of inflammation and necrosis (Johnson, 2000).

Johnson (2000) reported the occurrence of portal fibrosis in dogs with chronic hepatitis. Periacinar

fibrosis was seen with chronic passive congestion secondary to right sided heart failure or toxins. Diffuse hepatic fibrosis was found as a response to chronic parenchymal injury.

2.1.5. Infectious conditions

a) Bacterial etiology

Stedham (1977) diagnosed seven cases of Melioidosis in dogs. There were necrotic and purulent lesions in the liver. Diagnosis was confirmed by cultural, serological and histological methods.

A case of disseminated Protothecosis in a dog was reported by Gaunt *et al.* (1984). Extensive necrotic lesions were seen in the liver. *Prototheca* sp. was identified histologically, and was confirmed by cultural examinations.

Inoue *et al.* (1988) and Kitchell *et al.* (2000) reported Peliosis hepatitis in dogs caused by *Bartonella henselae*. Liver sections revealed cystic lesions and sinusoidal dilatation.

Forester *et al.* (1992) isolated *Klebsiella* sp. from the liver of a dog with cholangiohepatitis. Periacinar hepatocellular degeneration, moderate portal

infiltration and hypertrophy of Kupffer cells were noticed.

Bornand-Jaunin *et al.* (1993) observed infarction and necrosis in the liver of a dog from which *Clostridium perfringens* was isolated.

Arnbjerg and Jensen (1994) isolated Streptococci (Type G), from hepatic abscess in a puppy. Miller *et al.*(1996) isolated *Escherichia coli, Enterobactor aerogenes, Proteus vulgaris* and *Clostridium hemolyticum* from a dog with hepatic abscess, while Johnson (2000) isolated *Staphylococcus, E.coli, Salmonella* and *Clostridium* species from hepatic abscess in dogs.

A case of Anthrax in a dog was reported by Mc Gee *et al.*(1994) Necropsy findings revealed a friable liver. Histologically, bacteria were seen in the hepatic sinusoids.

Adamus *et al.*(1997) identified lesions in the liver in Leptospirosis. Grossly, liver was firm, tan coloured and mottled. Microscopic lesions ranged from severe chronic hepatitis to mild hepatocellular vacuolation with lymphocytic aggregates. Special stains revealed spirochaetes within the bile canaliculi.

b) viral etiology

Smith *et al.* (1972) studied lesions in Infectious Canine Hepatitis in dogs. There was congestion of liver and spleen with oedema of gall bladder. Microscopically periacinar hepatic necrosis was seen with intranuclear inclusions in the hepatocytes.

Jarret *et al.* (1987) reported hepatitis and chronic fibrosis induced by Canine acidophil cell hepatitis virus. Sustained inflammatory response was absent.

Canine adenovirus inclusion bodies were demonstrated in the liver associated with hepatocellular necrosis in a dog with concomitant infection of Canine Distemper virus and Infectious Canine Hepatits virus (Kabayashi *et al* , 1993).

c) Fungal etiology

Ontario (1991) reported the occurrence of disseminated Histoplasmosis in a dog. The liver surface showed a granular appearance and histologically, histoplasmal yeast forms were seen.

A case of disseminated Coccidioidomycosis was diagnosed in a terrier. Multifocal granulomas were seen

in the liver, along with deposits of amyloid (Wohlsein *et al.*, 1993).

2.1.6. Toxic conditions

A fatal case of hepatitis and jaundice due to phenytoin toxicity in a dog was reported by Nash *et al.* (1977). Postmortem examination suggested hepatorenal failure with dissociation of hepatic lobules and presence of multinucleate or necrotic hepatocytes.

Lesions in glucocorticoid induced hepatopathy were studied by Rogers and Ruebner (1977) Sharma and Dakshinkar (1992) and Rutgers (1996). Liver sections revealed cloudy swelling, fatty changes, centrilobular vacuolisation, glycogen accumulation within hepatocytes and focal centrilobular necrosis.

Hepatitis and hepatocellular damage were reported in dogs administered with sulfonamides (Toth and Derwelis, 1980; Rowland *et al.* 1992).

Polzin *et al.* (1981) reported acute hepatic necrosis in dogs dosed with mebendazole for parasite control. Generalised centrilobular necrosis was found.

Copper toxicosis in dogs was described by Robertson *et al.* (1983); Thornburg *et al.* (1984)

Thornburg *et al.* (1986), Herrtage *et al.* (1987), Haywood *et al.* (1988) and Noaker *et al.* (1999). Hepatocellular degeneration, necrosis, intracanalicular cholestasis, inflammation and cirrhosis were the histological changes.

Pathologic findings of blue-green algae intoxication in the liver of dogs was reported by Kelly and Pontefract (1990) and Devries *et al.* (1993). Grossly the liver was large, friable and dark red. Histologically hepatocyte dissociation, degeneration and necrosis were found.

Little *et al.* (1991) reported an acute case of hepatocellular damage and cholestasis in a dog following ingestion of mycotoxins.

Papaioamnou *et al.* (1998) studied lesions in lead poisoning in dogs and reported that degeneration of hepatocytes with characteristic intracytoplasmic and intranuclear lead inclusions were the consistent lesions.

2.1.7. Parasitic conditions

a) Nematodes:

Progressive enlargement and congestion of the liver with distension of the gall bladder were the lesions seen in dogs infected with Ophisthorchiasis (Ansari and Prasad, 1975; Kumar *et al.*, 1991).

Dade and Wiliams (1975) described a case of Ascariasis in a dog where adult ascarids were embedded in the liver parenchyma. Microscopically, bile ducts were dilated and contained ova of *Toxacara canis*. Similar findings were reported by Schulze *et al.* (2000).

b) Cestodes:

Losson and Coignoul (1997) reported a case of larval *Echinococcus multilocularis* in a dog. The liver was distorted with nodular lesions. Microscopically, cystic spaces surrounded by inflammatory cells were seen.

c) Protozoans:

Lesions in canine Leishmaniasis were reported by Al-Shanawi *et al.* (1986); Gonzalez *et al.* (1988); Carrasco *et al.* (1997). Acute hepatocellular

degeneration and presence of amastigotes were the important findings as noted by Oliveira *et al.* (1993). Epithelioid granulomata inside the sinusoidal capillaries was characteristic in canine Leishmaniasis.(Tafuri *et al.* 1996)

Harrus *et al.* (1995) diagnosed *Trypanosoma congolense* infection in dogs. Hepato-splenomegaly and lymphocyte- plasmacytic infiltration were consistent findings.

d) Ectoparasites

Ilkiw *et al.* (1987) recorded histological findings in eight dogs infected with Ixodes holocyclus and found that moderate to severe congestion of the liver was significant.

2.1.8. Neoplastic conditions

2.1.8.1. Primary tumours

Primary hepatocellular carcinoma in dogs were described by Itoh *et al.* (1992); Une *et al.*, (1996)and Shiga and Shirota (2000). A number of pale stained enlarged cell foci composed of hepatocyte like cells expressing bipotential features of hepatic stem cells were seen.

Fry and Rest (1993) and Wadhwa *et al.* (1996) reported cases of cholangiocarcinoma in dogs. Grossly livers showed multiple nodular growths over the entire surface and histologically, neoplastic cells were arranged in microacinar pattern, with granular cytoplasm. Fibrosis and necrosis were also noted.

Fry and Rest (1993) diagnosed adenocarcinoma of the liver in a dog. The tumour had acinar arrangement and cyst formation. Mitotic figures exceeded ten per high power field.

2.1.8.2. Metastatic tumours

Saik *et al.* (1987) diagnosed a case of metastatic liposarcoma in the liver of a dog. Multiple masses consisting of well differentiated adipocytes were seen in the hepatic parenchyma.

Chronic myelogenous leukemia as a metastastic tumour in the liver was reported by Grindem *et al.* (1992). Liver was infiltrated with blast cells, maturing granulocytes and erythroid precursors.

Sanders *et al.* (1996) reported a case of undifferentiated metastatic sarcoma of the liver. Numerous spindle shaped cells were seen along with oval cells having dense nuclei and abundant cytoplasm.

2.2. Kidney

2.2.1. Prevalence

Kidneys from 71 stray dogs autopsied were examined by fluorescence microscopy for evidence of glomerulonephritis. It was found that glomerulonephritis (GN) was more common in dogs than previously reported (Rouse and Lewis, 1975).

Lewis (1976) evaluated the results of 50 cases of glomerulonephritis in dogs and found that, males had increased predilection for proliferative GN and females for membranous nephropathy.

De-schepper and Schepper (1977) studied 1000 cases of renal failure in dogs. Among 35 cases of systemic infectious diseases, there were 11 cases of Leptospirosis. They emphasised the importance of extra renal disorders in the etiology of kidney disease.

A morphological study of kidneys of 101 dogs with and without clinical signs of renal disease revealed that about 90 per cent of dogs had glomerulopathy (Muller-peddinghans and Trautwein, 1977a). Lesions were classified as membranoproliferative, mesangial proliferative and mesangial sclerosing. Membranous and membrano proliferative GN were common in the middle

aged and older animals, whereas mesangial lesions were predominant in younger animals (Muller- peddinghans and Trautwein, 1977b).

Stoicher (1980) studied the pathology of urinary system in dogs and found that the common lesions were urolithiasis, nephrosclerosis, pyelonephritis, cysts, cystitis, tumours and whitish nodules due to migration of *Toxacara canis*.

Sabri and Hayward (1981) observed that the most frequent form of glomerulonephropathy in dogs was mesangial cell proliferation.

Picut and Lewis (1987) reviewed on canine hereditary nephropathies and noted that the breeds susceptible were : Beagle (agenesis); Cocker Spaniel (hypoplasia); Lhasa apso, Shihtzu, Poodle (dysplasia); Cairn terrier (Primary cystic disease); Samoyeds, Doberman pinchers (glomerulopathy); Basenji, Dalmatians (Tubulo-interstitial nephropathy).

Minkus *et al.* (1994) suggested that there was no relationship between different types of nephropathy and age, nevertheless, animals with chronic tubulo-interstitial nephritis were on an average older than animals with glomerulopathies.

Kulkarni *et al.* (1997) studied the incidence of canine renal disorders and recorded that the highest incidence was in animals belonging to the age group 5-10 years. There was a preponderance of males with renal disorders. Among breeds, Spitz and Alsatians showed a higher incidence.

Ling *et al.* (1998a) analysed the prevalence of urinary tract infection and found that *Staphylococcus intermedius* was the commonly isolated bacterium.

2.2.2. Anomalies in development

Klopfer *et al.* (1975) reported renal cortical hypoplasia in a dog. The kidneys were smaller and had multiple cysts. Histologically, hypoplasia of the cortex was accompanied by sclerosis and calcification. Similar findings were reported by King (1999b).

Mckenna and Carpenter (1980) reported polycystic disease of the kidney in two Cairn terriers. The kidneys contained multiple fusiform cysts lined by cuboidal to slightly flattened epithelium. Fibrous tissue proliferation was also observed. Similar condition in Bull terriers was reported by Burrows *et al.* (1994) and O'Leary *et al.* (1999).

Report of the presence of a third kidney in a dog was made by Odendal (1992). It was accidentally discovered during panhysterectomy as a firm encapsulated mass, which on histological examination was identified as normal kidney tissue.

2.2.3. Vascular changes

Bjotvedt (1986) reported spontaneous renal arteriosclerosis in Greyhounds. Renal vessels had intimal thickening, fragmented internal elastic membrane and fibrosis of the inner portion of the tunica media.

Idiopathic renal haemorrhage in dogs was reported by Holt *et al.*(1987). Microscopically, extensive haemorrhages were seen in the cortex and medulla. The cause was unidentified.

2.2.4. Hydronephrosis

Sastry (1983a) stated that kidneys with hydronephrosis appeared like a bag with thin capsule. Microscopically, there was atrophy of the tubules which were widely dilated. Fibrous tissue proliferation was also noted.

Newman and Chapman (1984) reported a case of unilateral hydronephrosis secondary to renal calculus in a dog. Radiographic examination revealed dense mineralised areas in the right renal pelvis. Right kidney was one and half times the size of the left kidney. A similar case of bilateral hydronephrosis was reported by Blackwood *et al.* (1992).

A case of bilateral hydroureter and hydronephrosis, secondary to ovario-hysterectomy was identified by Gopegui *et al.* (1999). Bilateral ureter stenosis was seen in vesical trigone.

2.2.5. Glomerular disorders

2.2.5.1. Glomerulonephritis

Vilafranca *et al.* (1994) classified glomerulopathy based on histological and immunohistochemical study of kidneys in 115 dogs. Eight different types of glomerular lesions were identified viz., minor glomerular abnormalities, focal and segmental hyalinosis, focal glomerulonephritis,diffuse membranous glomerulonephritis, diffuse mesangial proliferative glomerulonephritis, diffuse endocapillary proliferative glomerulonephritis, diffuse mesangiocapillary

glomerulonephritis, diffuse sclerosing glomerulonephritis and unclassified glomerulonephritis.

However most workers have classified them under the following types.

(i) Membranous nephropathy

Smith *et al.*(1972) reported thickening, splitting and reduplication of glomerular basement membrane in membranous nephropathy. The thickening was visualised by PAS staining technique. They had also observed the occurrence of membranous nephropathy in Canine Systemic Lupus Erythematosis (SLE).

Murray and Wright (1974) suggested that there was diffuse irregular thickening of the glomerular capillary basement membrane in membranous nephropathy. They found that it was due to excessive synthesis of basement membrane material or the trapping and deposition of macromolecular materials. Association of glomerulopathy with cirrhosis and defective hepatic trapping of immunoglobulins were suggested.

Jaenke and Allen (1986) investigated on membranous nephropathy in dogs and found that renal lesions were characterised by the presence of sub-epithelial

immunoglobulin deposits along the glomerular capillary walls.

Cheville (1989) observed that membranous glomerulonephritis characterised by thickening of the glomerular capillary loop and mesangium was associated with purulent pyometra in dogs.

(ii) Proliferative glomerulonephritis

Murray and Wright (1974) conducted studies on canine glomerulonephritis and reported that proliferative glomerulonephritis was the common condition characterised by proliferation of mesangial cells.

Morrison and Wright (1976) suggested that increase in the cellularity in proliferative glomerulonephritis was mainly due to proliferation of mesangial cells and may sometimes be augmented by infiltration of polymorphonuclear leukocytes into glomerular tuft. They classified proliferative glomerulonephritis into three types- diffuse, segmental and focal.

(iii) Exudative glomerulonephritis

Exudative glomerulonephritis was a common lesion in viral disease of dogs especially in Infectious

Canine Hepatitis (ICH) (Wright, 1973). Hyperemia, edema and severe swelling of endothelial cells were the lesions noticed. In adenovirus infection, virions were located in the nuclei of endothelial and mesangial cells.

Morrison and Wright (1976) stated that the main pathological feature in exudative glomerulonephritis was the presence of large fibrin deposits in the walls of the glomerular capillaries with capsular adhesions and adherent glomerular segments.

(iv) Immune complex glomerulonephritis

Vegad and Katiyar (1998) suggested that Immune complex glomerulonephritis in dogs occurred in conditions like ICH, pyometra, Dirofilariasis, Autoimmune hemolytic anemia and SLE. Adhesion between the glomerulus and Bowman's capsule, hypertrophy and hyperplasia of parietal epithelium and dilatation of tubules with proteinacious fluid were the changes noticed.

2.2.5.2. Other glomerular lesions

Glomerular lesions in dogs with hyperglycemia and or glucosuria were investigated by Nakayama *et al.* (1986). Microaneurysm, focal or diffuse sclerosis,

obliteration or exudative lesion in the renal glomeruli were observed.

Cheville (1989) observed that lipid glomerulopathy, a rare condition with unidentified etiology has been reported only in dogs. Mesangial cells were expanded by large amount of neutral lipid globules.

Glomerular amyloidosis was reported by Bowels and Mosier (1992) and Mason and Day (1996). There were sclerosed glomeruli with thickened Bowman's capsule. Presence of amyloid was confirmed by Congo-red staining.

Cook *et al.* (1993) reported renal failure due to atrophic glomerulopathy in four dogs. The glomerular lesion was characterised by dilatation of Bowman's space with glomerular tufts absent or markedly atrophied. A hereditary cause was suspected.

2.2.6. Diseases of tubules

2.2.6.1. Acute tubular necrosis

Maxie (1993) suggested that acute tubular necrosis due to shock or ischemia was characterised by focal

necrosis of the proximal and distal convoluted tubules, tubulorrhexis and presence of casts in the lumen.

2.2.6.2. Nephrotoxic tubular necrosis

Kitchen *et al.* (1975) studied ochratoxin A and citrinin induced nephropathy in Beagle dogs. At necropsy, renal tubular necrosis in the straight segments of the convoluted tubules and in the collecting ducts were seen.

Focal renal tubular necrosis was found in digoxin toxicity in dogs (Bourdois *et al.*, 1982).

Lesions in ethylene glycol poisoning were enlargement of the kidney with presence of calcium oxalate crystals in the parenchyma. Degeneration and necrosis of epithelial cells were also seen (Furher and George, 1989; Herd, 1992; and Byan-Hongsub *et al.*, 1998).

Kamphues *et al.* (1990) identified pathological changes in Vitamin D intoxication in puppies fed with milk replacer. There was renal calcification and sclerosis, fibrosis of the glomeruli and dilatation of the tubules.

Bark and Perk (1995) reported a case of Amoxicillin toxicity in a dog. Proximal tubular dysfunction was observed. Lesions were similar to Fanconi syndrome in man.

Acute intrinsic renal failure was diagnosed in a two-year old male German Shepherd dog, following *Vipera aspis* bite. Histopathologically, kidneys revealed glomerular hypercellularity, mesangial lysis, necrosis and hyaline casts in the lumen of the tubules (Puig *et al.*, 1995).

Papaioamnou *et al.* (1998) studied the histopathological lesions in lead intoxicated dogs and found that there was degeneration of the endothelial cells of the renal capillaries and epithelial cells of the tubules. Needle like lead inclusions were observed in the interstitial connective tissue cells of the kidney.

2.2.6.3. Specific tubular dysfunctions

Smith *et al.*(1972) stated that Dalmatian dogs excreted excess urates due to a tubular resorptive defect and found that it was not due to a deficiency of uricase or the rate of urate metabolism.

A specific type of tubular dysfunction, similar to the Fanconi syndrome in humans was reported in Basenjis by Bovee (1979). Lesions of acute renal failure were noted with interstitial fibrosis, tubular atrophy and papillary necrosis.

2.2.7. Tubulo-interstitial disorders

2.2.7.1. Interstitial nephritis

Cheville (1989) suggested that the most common bacterial organisms isolated from dogs with interstitial nephritis were *E. coli*, *Corynebacterium pyogenus*, *Sterptococcus sp.* and *Shigella sp.*

Birnbaum *et al.* (1998) found that diffuse interstitial nephritis was the significant finding in canine leptospirosis. Grossly, kidneys had discrete yellow to whitish areas and haemorrhages on the surfaces. Histological examination revealed moderate to severe lympho plasmacytic and neutrophilic tubulo-interstitial nephritis. Spirochaetes were identified in the renal collecting tubules.

Vegad and Katiyar (1998) stated that infectious canine hepatitis virus caused interstitial nephritis in the dog. Tubular necrosis, lymphocytic and plasmacytic interstitial nephritis were observed. Basophilic

intranuclear inclusion bodies were also seen in the epithelium.

2.2.7.2. Pyelonephritis

Lesions in pyelonephritis in dogs were studied by Smith *et al.*(1972), Cheville (1989), Maxie (1993) and Vegad and Katiyar (1998). It was found that pyelonephritis occurred more frequently in females and the organisms responsible were *E. coli.*, Proteus, Klebsiella, Staphylococcus, Streptococcus and *Pseudomonas auregenosa*. Microscopical lesions observed were intense neutrophilic infiltration in the interstitium, haemorrhage, oedema and coagulative necrosis of the inner medulla.

2.2.7.3. Granulomatous nephritis

Kabay *et al.* (1985) reported nine cases of granulomatous nephritis due to *Aspergillus terreus* infection in dogs. The kidneys had irregular, pitted and roughened capsular surface with yellow spherical foci. Microscopically granulomas with lymphocytes and plasmacytes were seen. The fungal hyphae were demonstrated by Grocott- Gomori silver stained sections.

Maxie (1993) reported that granulomatous nephritis in dogs was common in *Toxacara canis* infection. Small granulomas composed largely of epithelial cells and lymphocytes with occasional eosinophils were seen.

Unilateral renal fungal infection with extensive granulomatous nephritis in a dog was reported by Day and Holt (1994). Fusarium spp. was identified as the causative organism.

2.2.8. Parasitic conditions

Lesions in canine heart worm infection was studied by Aikawa *et al.* (1981) and Grauer *et al.* (1987). Glomeruli of dogs with high microfilaraemia showed a moderate increase in the mesangium and thickened glomerular basement membrane due to the *in situ* formation of immune complexes.

Celerin and Mcmulleu (1981) reported *Dioctophyma renale* infection in a dog. The worms were seen in the renal pelvis. Haemorrhagic or purulent pyelitis with destruction of renal parenchyma was noticed.

Naskidachvili and Peroux (1988) Nieto *et al.* (1992) Font *et al.* (1993) studied the pathology of canine Leishmaniasis and found that acute or chronic

glomerulonephritis with hyalinosis were the characteristic lesions.

Harrus *et al.* (1995) diagnosed Trypanosomiasis in two dogs and found that haemorrhages and lymphoplasmacytic infiltration in the kidneys were the main lesions.

Renal pathology in *Babesia canis* infection was studied by Lobetti *et al.* (1996). Histological examination revealed a mild, single cell tubular necrosis.

Vegad and Katiyar (1998) studied the lesions in *Capillaria plica* and *Capillaria feliscati* infection in dogs and found that inflammatory cellular infiltration and focal haemorrhage were the main lesions.

2.2.9. Urolithiasis

Sastry (1983a) stated that oxalates, urates, uric acid, cystine, triple phosphates, calcium carbonate and phosphates were the common calculi in dogs. It was also suggested that uric acid calculi were common in Dalmatians. Case *et al.* (1993) also suggested that the risk of forming urate calculi was high in Dalmatians.

Ling *et al.* (1998b) statistically analysed the mineral prevalence of urolithiasis in dogs. It was found that higher proportions of struvite, apatite and urate were found in uroliths in females while, oxalate, cystine and silica were more in males.

Breed predisposition to urolithiasis was studied by Ling *et al.* (1998c). It was found that oxalate calculi were seen in higher proportion in Lhasa-apsos and Cairn-terriers, lowest in Dalmatians. English bull dogs and Dalmatians had the highest number of urate calculi while, Samoyeds had the lowest.

2.2.10. Neoplastic conditions

2.2.10.1. Primary tumours

Lium and Moe (1985) described a syndrome characterised by bilateral, multifocal renal cystadeno-carcinomas and nodular dermatofibrosis in 43 German Shepherd dogs. Kidneys revealed multiple solid and cystic tumours. Histopathological examination showed multifocal hyperplastic to malignant epithelial proliferation.

Umeda *et al.* (1985) reported a case of Nephroblastoma in a dog. The tumour mass was attached dorsally with kidney and had multilocular cysts.

Histologically, undifferentiated spindle cells were observed between the myxomatous tissue. Similar findings were reported in two other dogs by Watson *et al.* (1987).

Gross and histopathological lesions in the renal interstitial cell tumours in dogs were reported by Diters and Wells (1986). Histologically, all the nodules were uncapsulated and interstitial cells replaced the normal tissue.

Arai *et al.* (1991) reported a case of canine renal cell carcinoma. The kidney was replaced by a massive gourd shaped tumour. Histologically, the tumour was composed of papillary growths, solid areas and cystic portions.

2.2.10.2. Metastatic tumours

A lymphosarcoma originating from the kidney was diagnosed in a three year old dog. Grossly the kidneys were enlarged. Histologically a majority of the glomeruli and renal tubules were obliterated due to diffuse invasion by tumour cells (Zhao *et al.*1993).

Gross and microscopical features of a squamous cell carcinoma of the renal pelvis in a dog was described by Dagli *et al.* (1997). The kidneys were

smaller and had whitish nodules. Prickle cells and horny pearls could be seen histologically.

Hahn *et al.* (1997) reported a case of bilateral renal metastases of nasal chondrosarcomas in a dog. The tumour was formed by small pleomorphic cells and interspread islands of cartilage.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The present study was conducted at the Centre of Excellence in Pathology (CEP), College of Veterinary and Animal Sciences, Mannuthy to investigate the prevalence and pathology of the various disorders of the liver and kidney in canines and to classify the lesions encountered in these organs.

3.1. Materials

3.1.1. Data collection

Data regarding the prevalence of the liver and kidney disorders in canines for a period of five years from March 1995 to February 2000 were obtained from the records available at the Centre of Excellence in Pathology, College of Veterinary and Animal Sciences, Mannuthy.

The history and other details regarding the carcasses brought for autopsy to the CEP during the period of the study (March 2000- August 2001) were documented in the proforma prepared (Appendix-1) after getting the information from owners.

Data regarding the treatment, haematological and serum biochemical parameters were obtained from

Veterinary Hospital, Mannuthy for those cases which were referred from the hospital for post-mortem examination.

3.1.2. Sample collection

One hundred samples, each of the liver and kidney obtained from the carcasses of dogs brought for autopsy to the CEP between March 2000 and August 2001 were used for the study.

Urine samples were collected from the bladder in all the cases wherever it was available.

Materials for bacteriological studies were collected from the liver, kidney and heart blood in appropriate cases.

Liver was collected for estimation of the lead content from a suspected case of lead poisoning.

3.2. Methods

3.2.1. Analysis of the Data

The data collected from the records available at the CEP regarding the prevalence of the liver and kidney disorders in canines from March 1995 to February 2000 were analysed and lesions were classified.

The details regarding the age, sex, breed, history and clinical signs of carcasses brought for autopsy to

CEP during the period of the study were obtained and recorded in the proforma prepared. The weight of the carcasses and the individual weights of the liver and kidney were noted. The lesions were classified based on the age, sex and breed.

3.2.2. Gross examination

A detailed systematic postmortem examination of the canine carcasses brought for autopsy was conducted. The liver and kidney were dissected out separately and were carefully studied for gross lesions like changes in size, shape, colour, consistency and presence of cysts, abscess or tumours. The liver was dissected along with the biliary tract to examine for the presence of parasites. Multiple incisions were made and the cut surface was examined and abnormalities were recorded. Representative samples were collected for histopathological examination. Gross changes in other organs were also recorded.

3.2.3. Histopathological examination

Representative samples of the liver and kidney obtained from the carcasses were fixed in neutral buffered formalin and / or alcohol. They were then processed and embedded as

described by Sheehan and Hrapchak(1980). The sections were stained with Haematoxylin and Eosin as per the technique followed by Bancroft and Cook (1984). Special staining techniques like Van Gieson's for collagen fibres, Periodic Acid Schiff's (PAS) for the demonstration of basement membranes and glycogen, PTAH for fibrous tissue, Pearl's technique for haemosiderin, Alizarin-red-S for calcium and Oil-red-O for fats were done as and when required as per the method described by Luna (1968). The sections were examined in detail under light microscope and lesions were classified.

3.2.4. Basis for the histopathological evaluation of tissues

The liver lesions were scored under six primary markers viz., vascular disturbances, degenerative changes, inflammatory changes, proliferative changes, neoplastic changes and other disorders. Kidney lesions were scored under five primary markers viz., vascular disturbances, glomerular changes, tubular disorders, tubulo-interstitial disorders and other disorders (Appendix II). Lesions under each category were graded as mild, moderate or severe.

Glomerular lesions were broadly classified as being focal, diffuse or segmental. The term focal was

used in situations in which lesions were seen in less than 50 per cent of the glomeruli. A diffuse lesion was one in which more than 50 per cent of the glomeruli exhibited pathological alterations. Lesions were segmental when only a part of the glomerular apparatus was affected.

Primary glomerular lesions were recorded under three categories (Appendix III).

1	Membranous nephropathy (MN) -	Thickening of the capillary basement membranes
2	Proliferative glomerulo nephritis- (PGN)	Mesangial proliferation
3	Membrano proliferative glomerulo nephritis (MPGN)	Combination of both

3.2.5. Urinalysis

The urine samples collected were analysed for gross (physical and chemical) and microscopic changes as per the methods described by Sastry (1983b).

3.2.6. Microbiological studies

Bacterial isolation was attempted from the liver, kidney and heart blood in all the fresh cases and

identification of the organisms was done following Cowan (1974).

3.2.7. Toxicological studies

In a suspected case of lead poisoning, the liver sample was processed by wet digestion method and the amount of lead in the sample was estimated spectrophotometrically.

RESULTS

4. RESULTS

4.1. Prevalence

Data regarding the incidence of hepatic and renal disorders in canines for the period between March 1995 and February 2000 (Five years) were collected from the records maintained at the Centre of Excellence in Pathology and analysed. Of the 1063 cases studied, 86 per cent revealed gross lesions in either liver or kidney or both. 75 per cent of cases had lesions in the liver and 82 per cent had lesions in the kidney.

Samples of the liver and kidney obtained from one hundred cases of canines autopsied at the Centre of Excellence in Pathology, College of Veterinary and Animal Sciences, Mannuthy between March 2000 and August 2001 were examined. Of these, 76 per cent showed pathological changes in the liver and 85 per cent showed pathological changes in the kidney. The lesions were classified based on the age (Table 1), sex (Table 2) and breed (Table 3). The lesions in the liver and kidney were graded as mild, moderate and severe and classified into different groups separately.

Table 1. Age-wise distribution of lesions in the liver and kidney

Group	Total	Numbers with liver lesions		Numbers with kidney lesions	
		Number	%	Number	%
< 1 year	23	16	70	20	87
1-3 years	31	25	81	28	90
3-5 years	21	15	71	15	71
>5 years	25	20	80	22	88
	100	76		85	

Table 2. Sex-wise distribution of lesions in the liver and kidney

Sex	Total	Liver lesions		Kidney lesions	
		Numbers	%	Numbers	%
Male	70	53	76	57	81
Female	30	23	77	28	93
	100	76		85	

Table 3. Breed-wise distribution of lesions in the liver and kidney

Breed	Total	Liver lesions		Kidney lesions	
		Numbers	%	Numbers	%
Non descript	34	25	74	28	82
German Shepherd	28	24	86	24	86
Others*	38	27	71	33	87
		76		85	

*- others include 9 Spitzs, 9 Cross breds, 5 Dobermans, 5 Daschunds, 3 Labradors 2 Boxers and one each of Roltweiler, Cockerspaniel, Great Dane, Coolie and Foxterrier. Their numbers being statistically insignificant were grouped together.

4.2. Classification of lesions

4.2.1. Liver

Seventy six per cent of cases revealed lesions in the liver. The lesions were classified and the percentage of occurrence of each lesion is shown in Graph 1. The lesions in most cases occurred in combination with the other lesions.

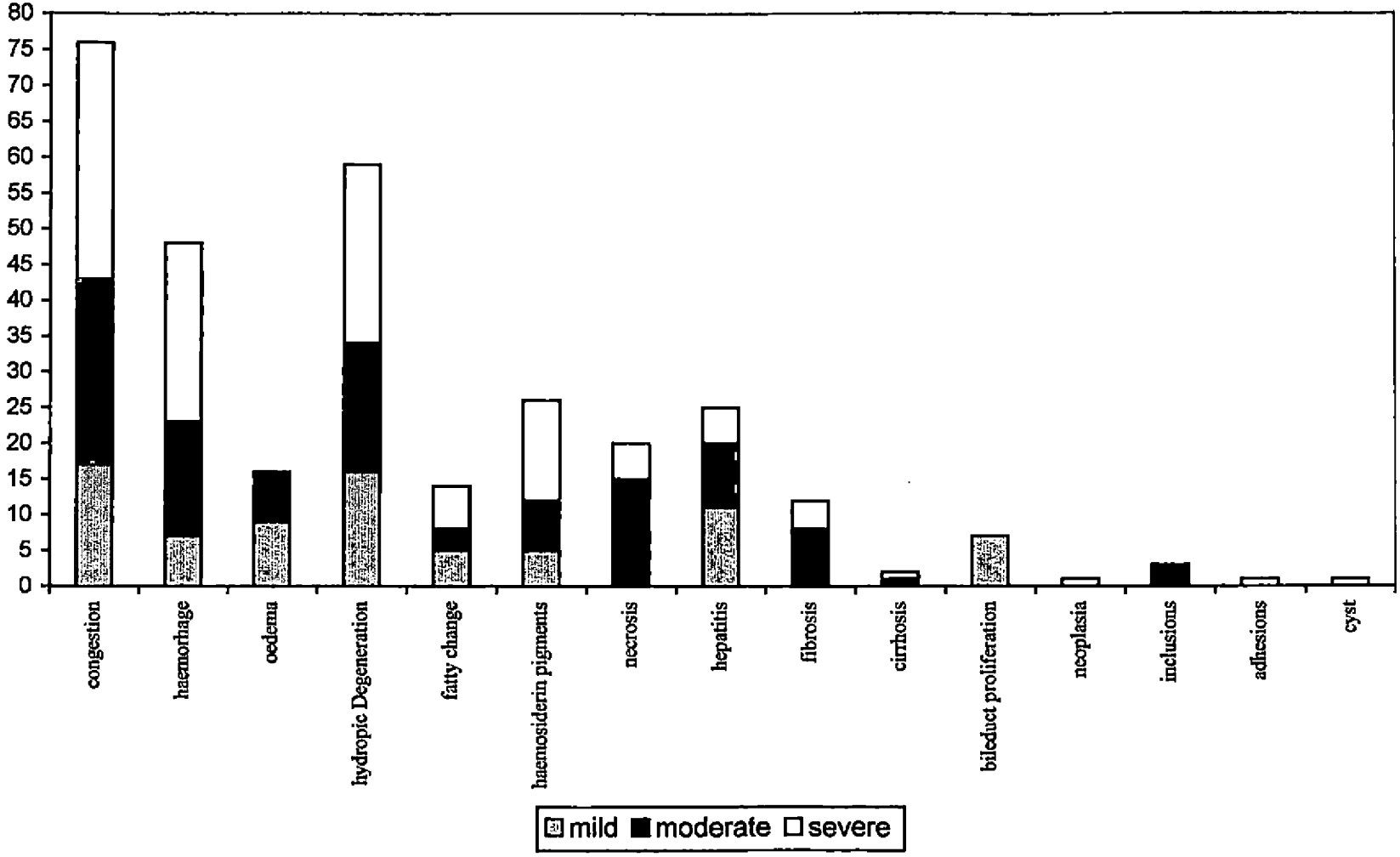
4.2.1.1. Vascular changes

Vascular changes were classified as congestion, haemorrhage and oedema.

4.2.1.1.1. Congestion

Out of the 76 cases with lesions in the liver, 58 (76 per cent) had congestion of varying degrees. Grossly, the organ appeared red and the cut surface revealed nut-meg appearance in some cases. In severe cases, there was rounding of edges of the lobes and the organ was firm. Histopathologically, the sinusoids, central veins and portal vessels were dilated and filled with blood, depending on the severity. In very severe cases, due to dilatation of sinusoids, there was thinning of hepatic cords.

Graph 1. Percentage incidence of lesions in liver



4.2.1.1.2. Haemorrhage

Thirty-seven cases (49 per cent) out of the 76 affected, revealed haemorrhages of varying degrees. Grossly, the organ exhibited patchy reddish areas or pin point areas of petichiae. Microscopically, diffuse collection of erythrocytes were seen displacing the parenchyma (Fig. 1).

4.2.1.1.3. Oedema

Oedema was noticed in 12 cases (16 per cent). Grossly there was no appreciable change. Microscopically, there was mild to moderate dilatation of the periportal areas with uniform pink stained material.

4.2.1.2. Degenerative changes

Degenerative changes were further classified as hydropic changes and fatty changes.

Grossly, the areas of degeneration appeared as diffuse, pale to yellowish streaks extending into the parenchyma. The cut surface revealed a cooked appearance. In cases with severe fatty changes, the liver was enlarged, yellowish in colour and the cut ends bulged out. Classification of degenerative changes was based on histopathological alterations.

4.2.1.2.1. Hydropic degeneration

Hydropic degeneration was recorded in 45 cases (59 per cent) out of the 76 livers with lesions. Microscopically, the cytoplasm of the hepatocytes were vacuolated. There was hepatocytomegaly with loss of architecture and cytoplasmic details. The enlarged hepatocytes were rounded and the cytoplasm was condensed into feathery strands between the vacuoles. In many cases, hydropic degeneration was accompanied by congestion, haemorrhage and fatty changes also. Isolated hepatocytes with pyknotic nuclei were seen scattered throughout the parenchyma. In three cases, the vacuoles contained PAS positive inclusions, which was seen as pinkish spherical material when stained by PAS indicating the presence of glycogen.

4.2.1.2.2. Fatty changes

Eleven cases (14 per cent) out of the 76 affected livers had fatty change. The hepatic parenchymal cells contained fat globules either as a single large globule displacing the cytoplasm and compressing the nucleus or as multiple small globules (Fig. 2). The globules stained red with oil-red-o confirming that they were fat globules (Fig.3).

4.2.1.3. Pigment accumulation

Out of the 76 livers with lesions, 20 (26 per cent) showed hemosiderosis. Haemosiderin pigments were seen deposited as coarse granular yellowish brown pigments in areas where severe congestion and haemorrhages were seen. Pigments were stained blue with Pearl's stain (Fig.4) confirming that they were haemosiderin pigments.

4.2.1.4. Necrosis

Necrosis was seen in 15 cases (20 per cent). Grossly, the necrotic areas appeared as greyish white patches or spots distributed in the parenchyma. The cut surface had a cooked up appearance. Microscopically, the nuclei of the necrotic hepatocytes were in varying stages of pyknosis, karyorrhexis or karyolysis. The cytoplasm was homogenous and stained more pink. The normal sharp contour of the cells could not be seen and the cell outlines had disappeared. Six cases revealed focal necrosis where, multifocal groups of necrotic hepatocytes were seen distributed in the parenchyma. Grossly, the lesions were seen as minute pale yellowish foci, irregularly distributed in the parenchyma. Zonal necrosis was observed in seven cases of which two were centrilobular and five were periportal. Necrotic

hepatocytes were seen surrounding the central veins and portal areas respectively in such cases (Fig.5). In cases where centrilobular necrosis was seen, stasis of blood was also observed. Massive necrosis was seen in two cases where all hepatocytes in the section appeared necrotic. In three cases where focal necrosis was found, *E. coli* was isolated. Necrosis was mostly accompanied by vascular disturbances and hydropic degenerative changes.

4.2.1.5. Inflammatory changes- Hepatitis

Grossly, the livers had areas of focal or diffuse yellowish to greyish discolouration extending into the parenchyma. Nineteen cases out of the 76 cases (25 per cent) with liver lesions revealed hepatitis of varying types. Focal hepatitis was seen in one case where focal collection of mononuclear cells could be seen distributed throughout the parenchyma (Fig. 6). *E. coli* was isolated from the liver and kidney of this case which had lesions of chronic interstitial nephritis also. In another case of acute hepatitis, *Enterobacter aerogenes* was isolated from the liver and kidney. Histologically severe diffuse infiltration of neutrophils was seen in the liver. Acute interstitial nephritis was also noted in the kidney. Ten cases revealed portal hepatitis, where sparse number of

mononuclear cells were seen in the portal areas (Fig. 7). One case of suppurative hepatitis was recorded, where focal pin point whitish areas of developing abscesses, distributed diffusely in the parenchyma were seen grossly. Microscopically, such areas revealed a central eosinophilic material and intense infiltration of neutrophils around. A few lymphocytes were also observed (Fig. 8). Pyemic nephritis was also noted in the kidney of this animal. *Staphylococcus aureus* was isolated from the liver and kidney in this case. In all the above cases, inflammatory changes were accompanied by various other lesions like congestion, hydropic degeneration or necrosis.

4.2.1.6. Proliferative changes

4.2.1.6.1. Fibrosis

Nine cases (12 per cent) revealed fibrosis of the liver. Grossly, the livers were firm in consistency. Microscopically, there was loss of hepatic architecture. Fibrous tissue extended out irregularly from the portal areas into the adjacent parenchyma (Fig. 7). The hepatocytes revealed vacuolation of the cytoplasm and nuclear pyknosis. There was infiltration with mononuclear cells in the portal areas with scattered infiltration in the parenchyma. Focal or

multifocal hepatic fibrosis was seen in three cases, where fibrous tissue was scattered throughout the parenchyma. Six cases showed portal fibrosis. Fibrous tissue was stained red by special stains like Van Gieson's and PTAH.

4.2.1.6.2. Cirrhosis

Cirrhosis was observed in two cases. Grossly, the livers were hard and firm and the surface was nodular (Fig. 9). Ascites was present in both these cases where in there was accumulation of approximately two litres of clear straw coloured fluid in the abdominal cavity. Microscopically, the parenchyma was divided into islands separated by bands of fibrous tissue. There was loss of lobular architecture, the portal tracts and central veins having lost their regular spacing. The fibrous tissue proliferation was seen in between the parenchymal nodules, entrapping groups of liver cells, thus causing pseudolobulation. Lymphocytes and few plasma cells were seen infiltrating the connective tissue (Fig.10). The infiltration was focal in both the cases. The parenchymatous cells also showed various stages of degeneration like hydropic degeneration, fatty change and necrosis. There was a significant increase in serum ALT and ALP levels and a marked

decrease in serum albumin levels in one case of cirrhosis.

4.2.1.6.3. Biliary hyperplasia

Mild biliary hyperplasia was seen in five cases. There was proliferation of bile duct epithelium within the portal tracts and periportal region. They were seen as proliferating flattened cuboidal epithelial cells, stained blue with haematoxylin.

4.2.1.7. Neoplasia

A case of cholangiocarcinoma was diagnosed in a Pomeranian cross. At necropsy, the liver revealed multiple whitish hard nodular growths of varying sizes in all the lobes (Fig 11). Histopathology revealed striking fibrous tissue proliferation entrapping the neoplastic cells. The tumour was not well differentiated, which was indicated by the lack of acinar pattern of arrangement. The neoplastic cells revealed scanty cytoplasm with hyperchromatic, pleomorphic nuclei (Fig. 12).

4.2.1.8. Other disorders

4.2.1.8.1. Inclusion bodies

Intra-nuclear inclusions were seen in the hepatocytes in one case which had inclusions

in the glomerular epithelium also. Grossly, the liver was slightly enlarged and congested. The gall bladder was oedematous and had blood tinged inspissated material. The inclusions had a basophilic tint and displaced the nuclear contents. A halo could be seen around the inclusions (Fig.13 and 14). There was centrilobular necrosis of the hepatocytes in this case. Similar inclusions were seen in the hepatocytes in another case.

4.2.1.8.2. Adhesion of the diaphragm and liver

In one case, the diaphragm was seen adhered to the dorsal surface of the liver (Fig.15). Microscopically, there was congestion of sinusoids and central veins and degeneration of hepatocytes in the surrounding areas of adhesion. The diaphragm was seen adhered to the liver by connective tissue proliferation between the two. The connective tissue was stained red with PTAH (Fig.16).

4.2.1.8.3. Cyst

A case of hepatic cyst was observed in a dog. Grossly, a single large cyst of the size of a tennis ball with a clear fluid inside was seen in the dorsal lobe of the liver (Fig. 17). Microscopically, the cyst was lined by flattened cuboidal epithelium (Fig. 18). The adjacent hepatic parenchyma revealed thinning of

hepatocytes, firous tissue proliferation around the portal and central venous areas, stasis of bile in hepatocytes, congestion of central and portal vessels and hydropic changes in the hepatocytes.

4.2.2. Kidney

Out of the one hundred samples examined, 85 per cent had lesions in the kidney. The lesions were classified and the percentage of incidence of each lesion is shown in Graph 2. The different types of lesions in most cases occurred in combination with other lesions.

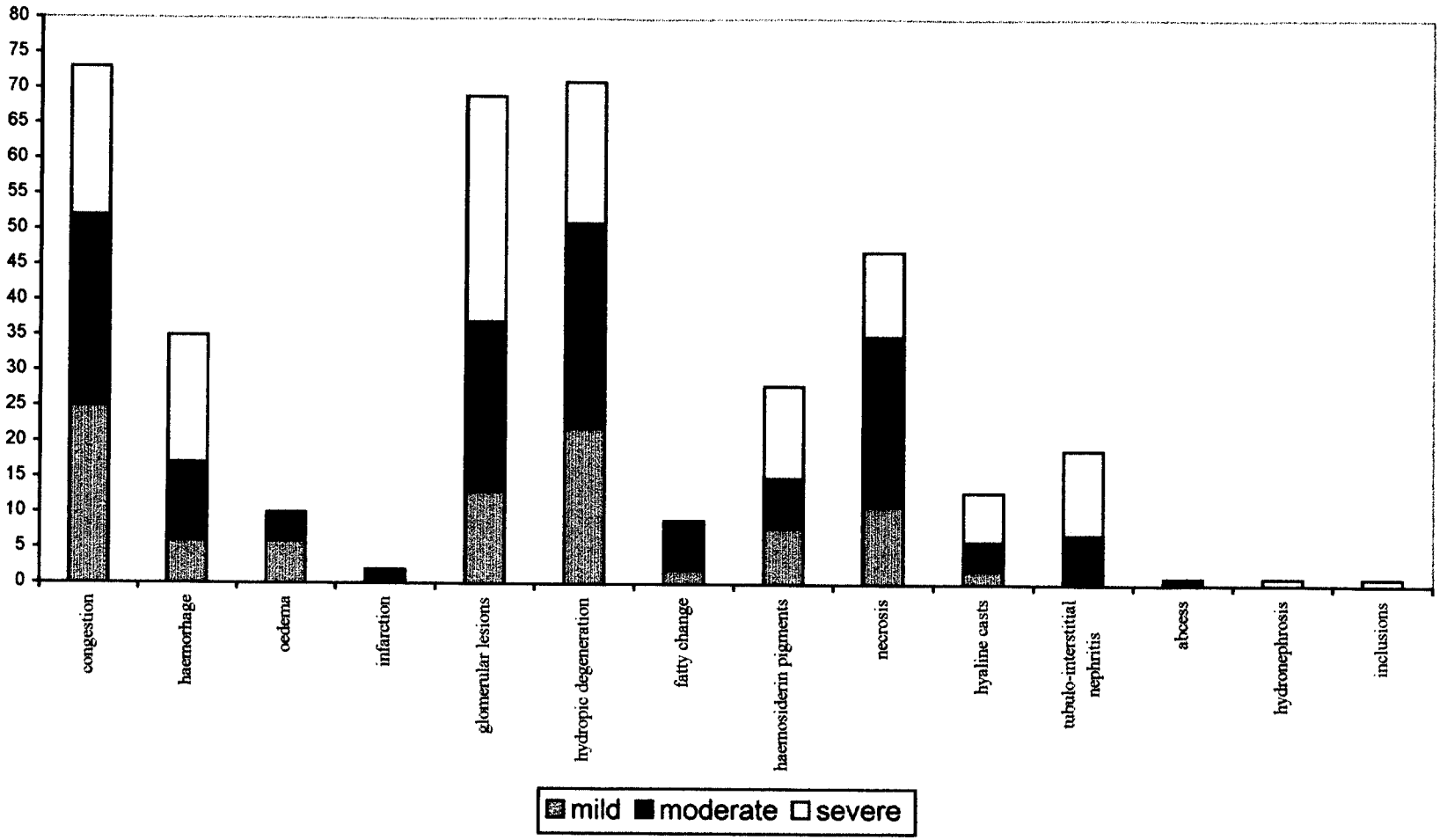
4.2.2.1. Vascular changes

Vascular changes were grouped under four categories viz., congestion, haemorrhage, oedema and infarction.

4.2.2.1.1. Congestion

Congestion of varying degrees was noted in 62 cases (73 per cent) out of the 85 cases that had lesions in the kidney. Grossly, the organ was dark red and blood oozed from the cut surface. Microscopically, the interstitial capillaries and blood vessels were distended with blood. In severe cases, the glomerular capillaries were also seen distended with blood.

Graph 2. Percentage incidence of lesions in the kidney



4.2.2.1.2. Haemorrhage

Haemorrhage in the kidney was observed in 30 cases (35 per cent). In severe cases, the kidneys were enlarged with subcapsular and intrarenal haemorrhages. Microscopically, erythrocytes were seen extravassated in the interstitium (Fig.19 and 20). In one case of suspected snake bite, severe heamorrhages were seen along with hyaline casts in the lumen of the tubules. Severe vascular changes were seen in other organs also.

4.2.2.1.3. Oedema

Oedema was observed in eight cases. Grossly, no significant change could be noted. Microscopically, pink staining material was seen in the intertubular spaces and perivascular areas which were widened.

4.2.2.1.4. Infarction

Wedge shaped red infarcts were seen in the cortex of the kidney in two cases. The apex of the wedge was towards the medulla and base towards the cortex. Microscopically, there was coagulative necrosis of the parenchyma with haemorrhages. There was fibroblastic proliferation and infiltration with mononuclear cells and macrophages.

4.2.2.2. Glomerular lesions

A total of 59 cases (69 per cent) revealed lesions of varying severity in the glomeruli. Glomerular lesions were broadly divided into two categories viz., glomerular nephritis and other glomerular changes. Glomerular nephritis was observed in 32 cases and was classified into three groups as membranous nephropathy (MN), proliferative glomerulonephritis (PGN) and membranoproliferative glomerulonephritis(MPGN). The incidence of the three types of GN along with the data regarding age, sex and breed of these animals is given in Tables 4,5,6 and Graphs 3,4,5. Other glomerular lesions included congestion, fragmentation and atrophy of the tuft, adhesion of parietal and visceral layers, exudation into the Bowman's space and thickening of the parietal layer. The incidence of each is given in Table 7. Most cases that had GN had other glomerular lesions also. In addition, these glomerular lesions were accompanied by various types of tubular and tubulo-interstitial lesions also.

4.2.2.2.1. Membranous nephropathy

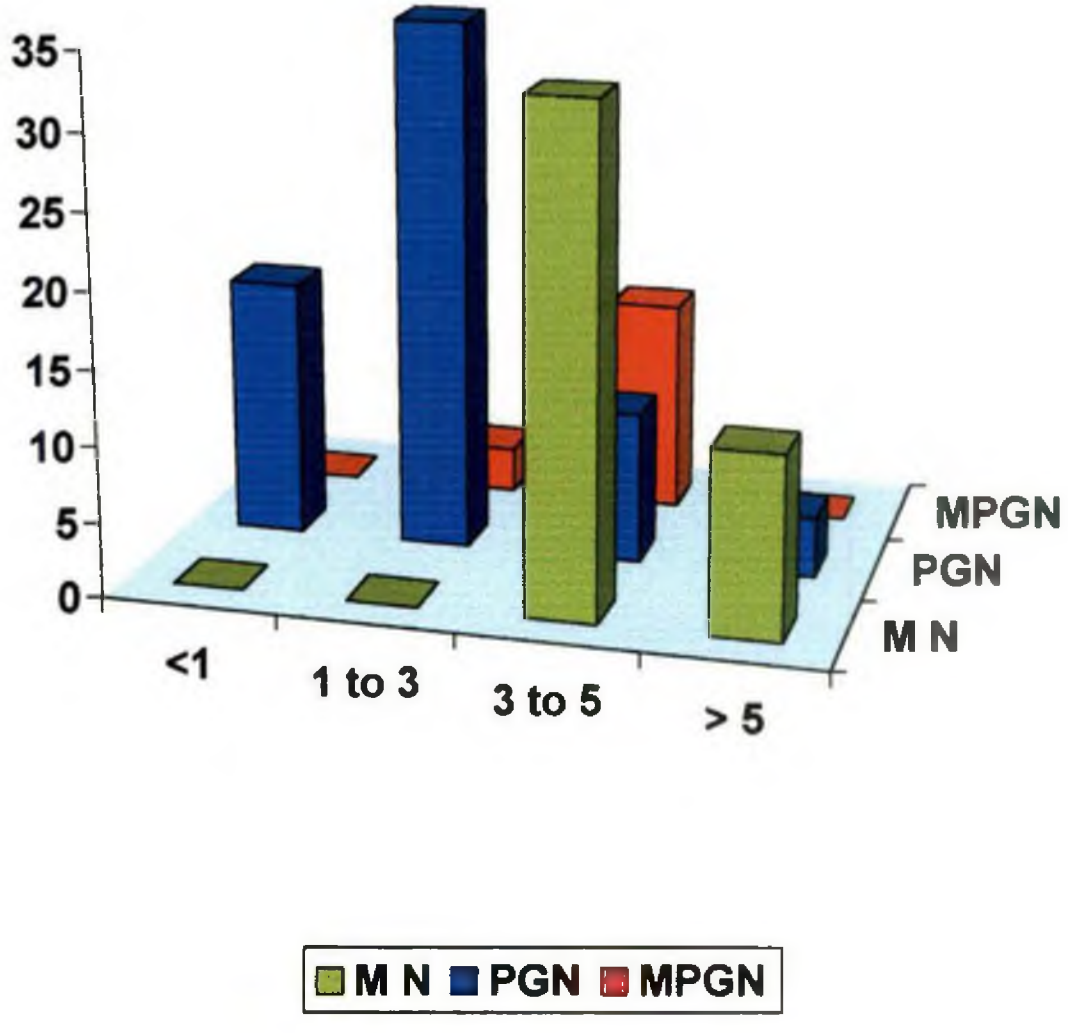
Ten cases out of the 32 cases of GN revealed membranous nephropathy, of which, seven were focal and three were diffuse. Grossly no appreciable change could

Table 4. Age-wise distribution of glomerulonephritis

Age	Total	MN				PGN					MPGN		Total	
		Focal	Diffuse	Total		Focal	Diffuse	Segmental	Total		No	%	No.	%
				No.	%				No.	%				
<1	23	0	0	0	0	1	3	0	4	17	0	0	4	17
1-3	31	0	0	0	0	3	8	0	11	35	1	3	12	39
3-5	21	6	1	7	33	2	0	0	2	10	3	14	12	57
>5	25	1	2	3	12	0	0	1	1	4	0	0	4	16
Total		7	3	10		6	11	1	18		4		32	

MN- Membranous nephropathy, PGN- Proliferative glomerulonephritis, MPGN- Membrano proliferative glomerulonephritis

Graph 3. Age-wise distribution of Glomerulonephritis (in Percentage)



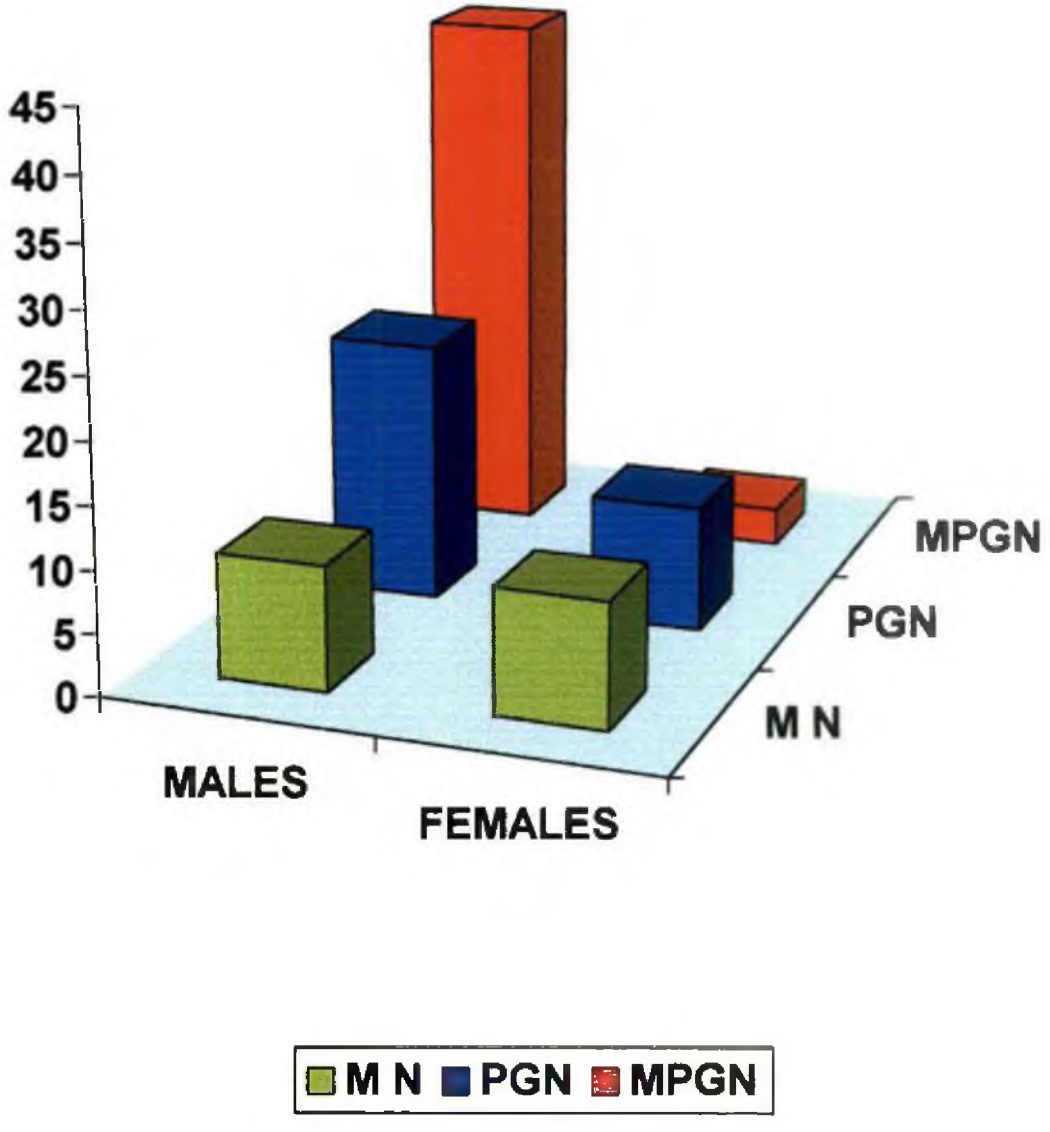
MN- Membranous nephropathy, PGN- Proliferative glomerulonephritis, MPGN- Membrano proliferative glomerulonephritis

Table 5. Sex-wise distribution of glomerulonephritis

Sex	Total	MN				PGN					MPGN		Total	
		Focal	Diffuse	Total		Focal	Diffuse	Segmental	Total		No	%	No.	%
				No.	%				No.	%				
Male	70	5	2	7	10	5	9	1	15	21	3	43	25	36
Female	30	2	1	3	10	1	2	0	3	10	1	3	7	23
Total	100	7	3	10		6	11	1	18		4		32	

MN- Membranous nephropathy, PGN- Proliferative glomerulonephritis, MPGN- Membrano proliferative glomerulonephritis

Graph 4. Sex-wise distribution of glomerulonephritis (in Percentage)



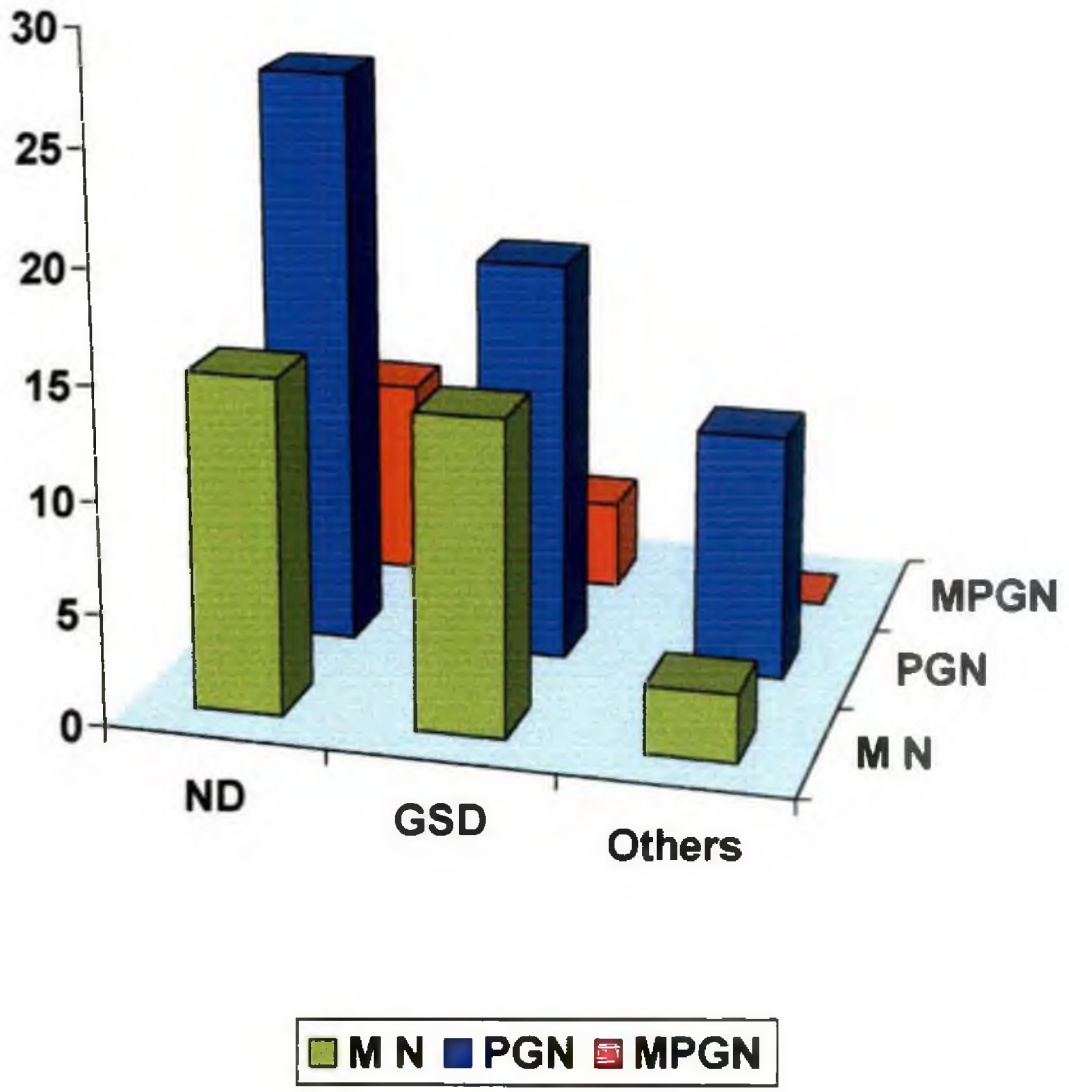
MN- Membranous nephropathy, PGN- Proliferative glomerulonephritis, MPGN- Membrano proliferative glomerulonephritis

Table 6. Breed-wise distribution of glomerulonephritis

Breed	Total	MN				PGN					MPGN		Total	
		Focal	Diffuse	Total		Focal	Diffuse	Segmental	Total		No	%	No.	%
				No.	%				No.	%				
Non descript	34	4	1	5	15	4	5	0	9	26	3	9	17	50
German Shepherd	28	3	1	4	14	2	3	0	5	18	1	4	10	36
Others	38	0	1	1	3	0	3	1	4	11	0	0	5	13
Total		7	3	10		6	11	1	18		4		32	

MN- Membranous nephropathy, PGN- Proliferative glomerulonephritis, MPGN- Membrano proliferative glomerulonephritis

Graph 5. Breed-wise distribution of glomerulonephritis (in Percentage)



MN- Membranous nephropathy, PGN- Proliferative glomerulonephritis, MPGN- Membrano proliferative glomerulonephritis

Table 7. Other glomerular lesions

Lesion	No.
Congestion of tuft	24
Fragmentation of tuft	21
Atrophy of tuft	18
Adhesion of parietal and visceral layers	17
Exudation in Bowman's space	24
Thickening of parietal layer	31

be noted. In some cases, the kidney was pale. Microscopically, the important change in the glomeruli consisted of thickening of the basement membranes of the glomerular capillaries. There was no proliferation of mesangial cells and no leucocytic infiltration. The capillary walls appeared thickened, eosinophilic and hyalinised in H & E sections. The thickened capillary basement membranes were visualised clearly by staining with PAS (Fig. 21). In most cases there was a thickening of the parietal layer of the glomerulus and occasional adhesion of the parietal and visceral layers. Hyaline casts were seen in the tubular lumina in many cases. All the eight cases in which urine samples were examined revealed proteinuria.

4.2.2.2.2. Proliferative glomerulo nephritis (PGN)

Eighteen cases of PGN were recorded. Of these, focal, diffuse and segmental lesions were seen in six, 11 and one cases respectively. Grossly, the kidneys with PGN appeared pale. Microscopically, proliferative glomerulonephritis was characterised by an increase in the glomerular cellularity due to proliferation of the mesangial cells (Fig. 22). In one case, it was augmented by infiltration with polymorpho nuclear leucocytes into the tuft (Fig. 23). The basement membrane of the glomerular capillaries showed no

obvious thickening. In most cases there was adhesion of the parietal and visceral layers. A few cases revealed atrophy of the tuft and exudation of fibrinous material. Urine analysis was done in nine cases and all had proteinuria.

4.2.2.2.3. Membranoproliferative glomerulonephritis

This type of GN was seen in four cases where both membranous and proliferative changes were observed. Grossly, the kidneys appeared normal. Microscopically, the glomeruli revealed thickening of the capillary basement membranes and hypercellularity due to proliferation of the mesangial cells. These lesions were accompanied by other degenerative changes in the glomeruli and tubules.

4.2.2.2.4. Other glomerular changes

Other glomerular changes like fragmentation of the tuft characterised by splitting of the glomerular tuft into fragments (21 cases), atrophy of the tuft noted as shrinkage of the glomerular tuft with dilatation of Bowman's space (18 cases), adhesion of parietal and visceral layers with obliteration of the Bowman's space (17 cases), exudation of fibrinous material in to the dilated Bowman's space (24 cases) (Fig. 24) and thickening of the parietal layer (31 cases) were also

observed. These glomerular changes co-existed with all other renal lesions.

In general, urine samples were available in 25 cases out of the 59 cases that had glomerular lesions and proteinuria was seen in 20 cases. Two cases were positive for sugar.

4.2.2.3. Tubular lesions

Tubular lesions were divided into hydropic degenerations, fatty changes, pigment accumulation and necrosis. These tubular lesions occurred concurrently with glomerular and interstitial lesions.

4.2.2.3.1. Hydropic degeneration

Hydropic changes were noted in 61 cases out of the 85 cases that had lesions. The change was characterised by the formation of clear cytoplasmic vacuoles displacing the nucleus and cytoplasmic contents towards the luminal side (Fig.25). Occasional epithelial cells showed pyknotic nuclei. Some of the tubules showed desquamation of the epithelium into the lumen. Grossly, focal or diffuse areas of pale discolouration could be noted in the kidney. The cut surface had a cooked appearance.

4.2.2.3.2. Fatty change

Fatty changes were recorded in eight cases. Microscopically, the tubular epithelium, especially the convoluted tubules contained distinct spherical fat globules of varying sizes, which was confirmed by Oil-Red-O staining technique.

4.2.2.3.3. Pigment accumulation

Haemosiderin pigments were seen in the renal parenchyma in 24 cases. Grossly, the kidneys appeared congested. Microscopically, the pigments appeared as coarse yellowish brown granules in areas where congestion and haemorrhage were present.

4.2.2.3.4. Necrosis

Necrosis of the renal tubules was observed in 42 cases out of the 85 cases that had lesions(49 per cent). At necropsy, the kidneys were swollen with diffuse or patchy areas of greyish white discolouration. The cut surface had a cooked-up appearance. Greyish white radiating streaks or lines could be seen in the cortical area. Microscopically, the cytoplasm of the tubular epithelium was eosinophilic with nuclear changes, which included pyknosis, karyorrhexis or karyolysis (Fig. 24). There was

exfoliation of the necrotic tubular epithelial cells into the lumen forming cellular or granular casts. Uniform pink stained proteinecious casts (hyaline casts) were seen in the lumen of the tubules in 11 cases (Fig. 26).

4.2.2.4. Tubulo-interstitial lesions

Tubulo-interstitial disorders included tubulo-interstitial nephritis and abscess. Tubulo-interstitial nephritis was observed in 16 cases and these were grouped into three catagories as pyelonephritis (2) acute, sub-acute and chronic interstitial nephritis (12) and pyemic nephritis (2). Their incidence based on age, sex and breed is shown in the Tables 8,9,10 and Graphs 6,7,8. One case of renal abscess was noted. Glomerulonephritis was also seen in 12 animals out of the 16 showing tubulo-interstitial nephritis.

4.2.2.4.1. Pyelonephritis

Two out of the 16 cases of tubulo-interstitial nephritis showed lesions of pyelonephritis. Grossly, there was moderate congestion in one case, while there was minute focal whitish areas extending into the parenchyma of the cortex in the other case. Microscopically, infiltration with radiating streaks of polymorpho nuclear cells were seen in the interstitium

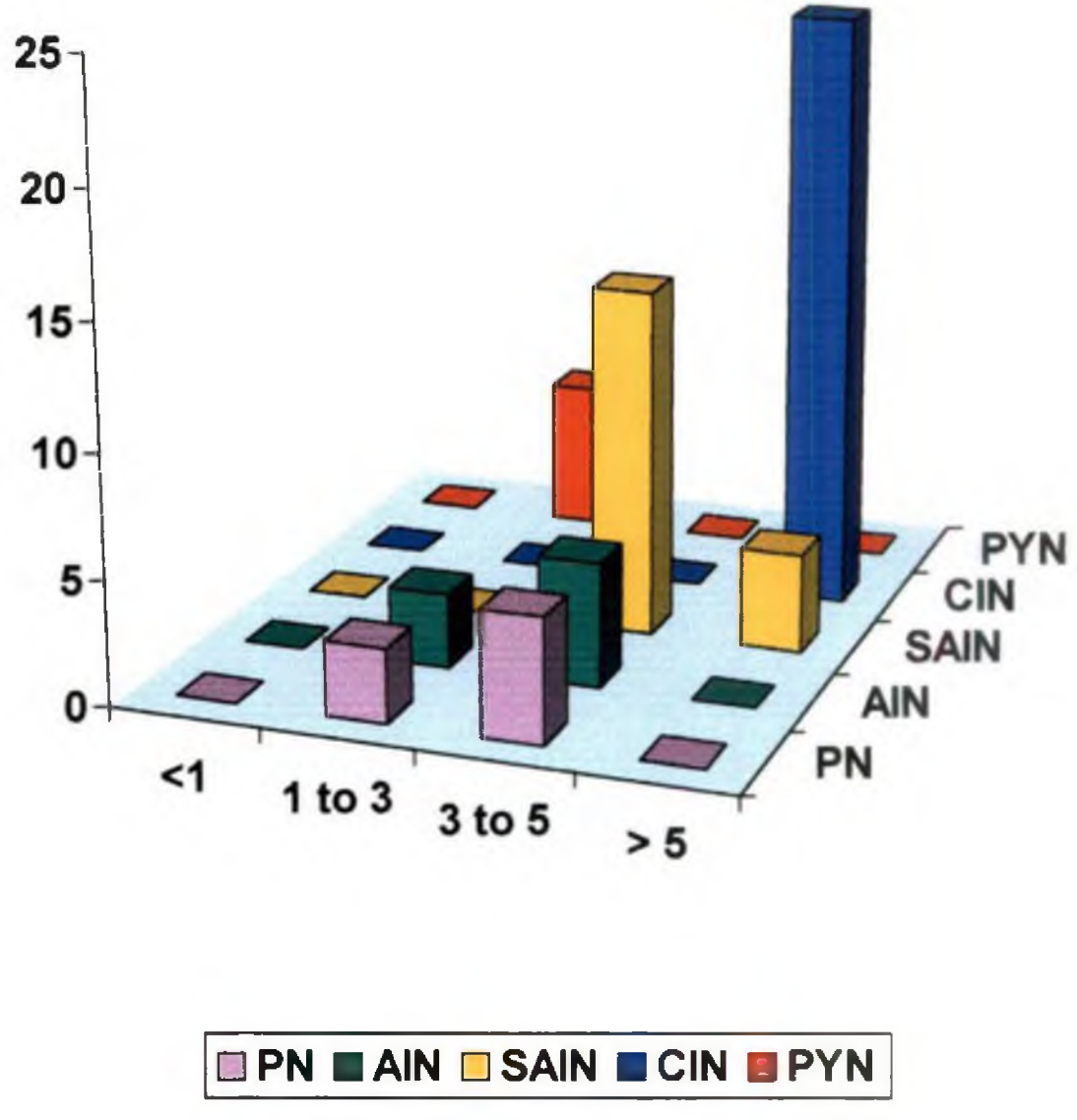
Table 8. Age-wise distribution of tubulo-interstitial nephritis

Age	Total	Pyleonephritis		Interstitial nephritis					Pyemic nephritis		Total	
		Total		AIN	SAIN	CIN	Total		No	%	No.	%
		No.	%				No.	%				
<1	23	0	0	0 (0)	0 (0)	0 (0)	0	0	0	0	0	0
1-3	31	1	3	1 (3)	0 (0)	0 (0)	1	3	2	6	4	13
3-5	21	1	5	1 (5)	3 (14)	0 (0)	4	19	0	0	5	24
>5	25	0	0	0 (0)	1(4)	6 (24)	7	28	0	0	7	28
Total	100	2		2	4	6	12		2		16	

AIN- Acute interstitial nephritis, SAIN-Subacute interstitial nephritis, CIN- Chronic interstitial nephritis.

Numbers in parenthesis indicate percentage.

Graph 6. Age-wise distribution of tubulo-interstitial nephritis (in Percentage)



PN- Pyelonephritis, AIN- Acute interstitial nephritis, SAIN- Subacute interstitial nephritis, CIN- Chronic interstitial nephritis, PYN- Pyemic nephritis

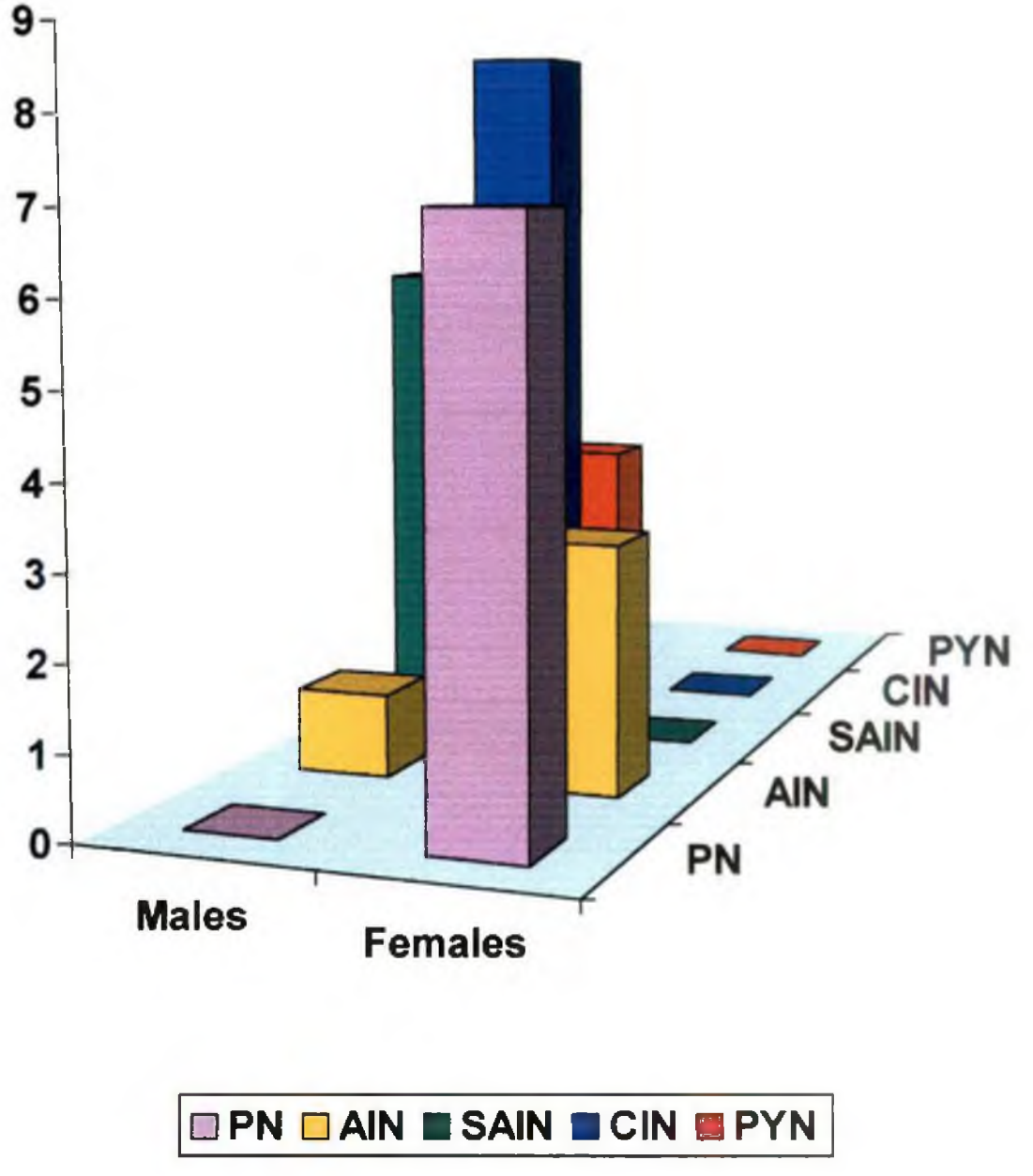
Table 9. Sex-wise distribution of tubulo-interstitial nephritis

Sex	Total	Pyleonephritis		Interstitial nephritis					Pyemic nephritis		Total	
		Total		AIN	SAIN	CIN	Total		No	%	No.	%
		No.	%				No.	%				
Male	70	0	0	1 (1)	4 (6)	6 (9)	11	16	2	3	13	18
Female	30	2	7	1 (3)	0 (0)	0 (0)	1	3	0	0	3	10
Total	100	2		2	4	6	12		2		16	

AIN- Acute interstitial nephritis, SAIN-Subacute interstitial nephritis, CIN- Chronic interstitial nephritis.

Numbers in parenthesis indicate percentage.

Graph 7. Sex-wise distribution of tubulo-interstitial nephritis (in Percentage)



PN- Pyelonephritis, AIN- Acute interstitial nephritis, SAIN- Subacute interstitial nephritis, CIN- Chronic interstitial nephritis, PYN- Pyemic nephritis

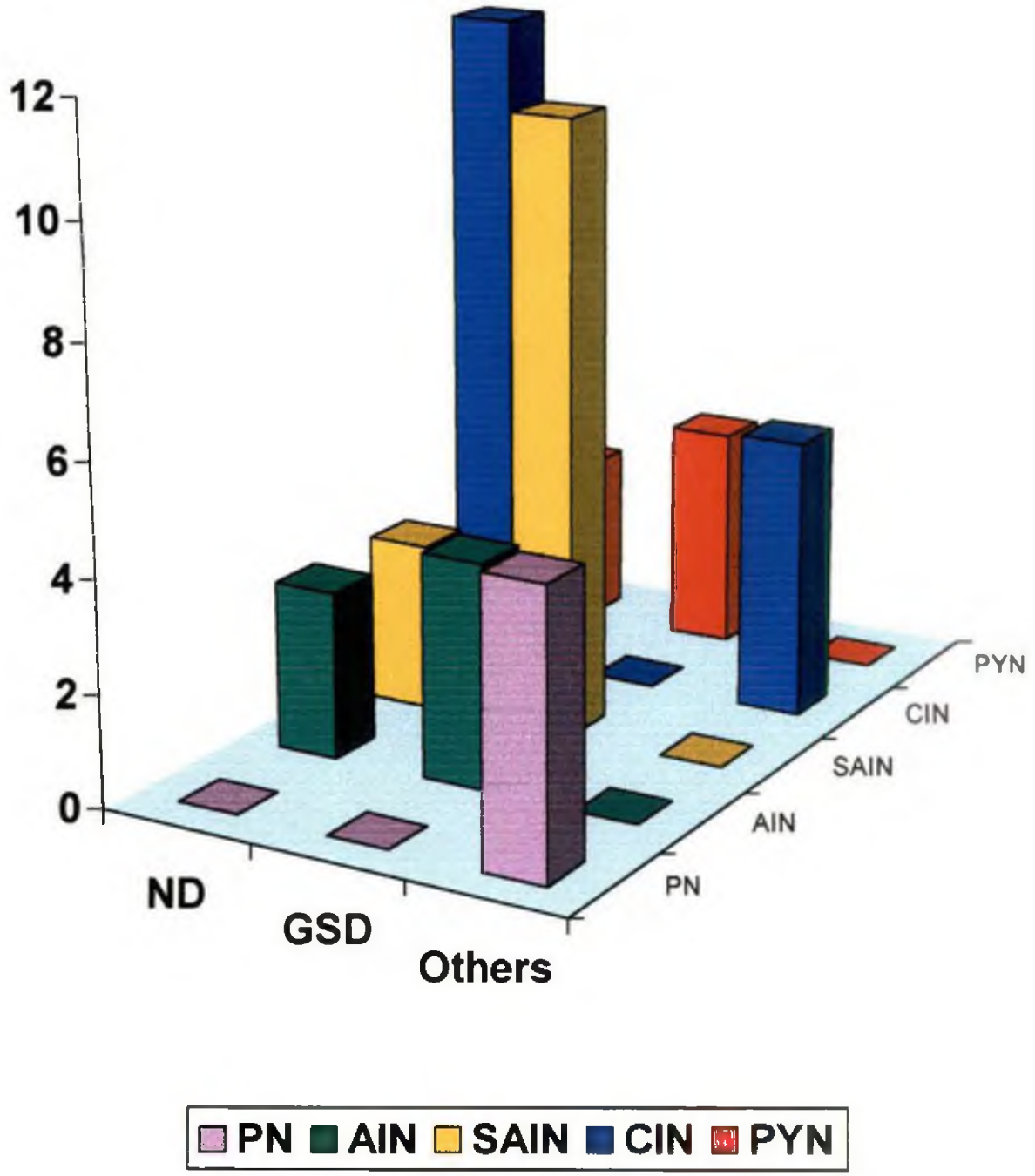
Table 10. Breed-wise distribution of tubulo-interstital nephritis

Breed	Total	Pyleonephritis		Interstitial nephritis					Pyemic nephritis		Total	
		Total		AIN	SAIN	CIN	Total		No	%	No.	%
		No.	%				No.	%				
Non descript	34	0	0	1 (3)	1 (3)	4 (12)	6	18	1	3	7	21
German Shepherd	28	0	0	1 (4)	3 (11)	0 (0)	4	14	1	4	5	18
Others	38	2	5	0 (0)	0 (0)	2 (5)	2	5	0	0	4	11
Total	100	2		2	4	6	12		2		16	

AIN- Acute interstitial nephritis, SAIN-Subacute interstitial nephritis, CIN- Chronic interstitial nephritis.

Numbers in parenthesis indicate percentage.

Graph 8. Breed-wise distribution of tubulo-interstitial nephritis (in Percentage)



PN- Pyelonephritis, AIN- Acute interstitial nephritis, SAIN- Subacute interstitial nephritis, CIN- Chronic interstitial nephritis, PYN- Pyemic nephritis

(Fig. 27). In one case, the glomeruli revealed hypercellularity, while membranous thickening was seen in the other. The tubular epithelial cells revealed hydropic degeneration and some areas of necrosis. The lumen of the tubules revealed uniform pink stained colloid like material in one case. Congestion of the interstitial capillaries was also observed. *E. coli* and *Pseudomonas aerugenosa* were isolated from each case respectively. Microscopical examination of urine in these two cases revealed an increase in pus cells and granular casts. Large number of bacterial rods could also be seen in the urine.

4.2.2.4.2. Interstitial nephritis

Twelve cases of interstitial nephritis were recorded of which, two were acute, four were sub-acute and six were of chronic types.

Kidneys with acute interstitial nephritis were of normal size and capsule was not adherent. Greyish focal areas of discolouration were seen in the cortex. Microscopically, severe diffuse infiltration with neutrophils were seen in the interstitium (Fig. 28). A few lymphocytes could also be seen. Severe congestion and tubular degeneration were the other changes. Hypercellularity of the glomerular tuft was seen in

both the cases. *Enterobacter aerogenes* was isolated from one case of acute interstitial nephritis from the kidney and liver. Hepatitis was also noted in this case. Urine from this case revealed the presence of blood.

In subacute and chronic interstitial nephritis, kidneys were smaller in size and the capsule was adherent. The surface was uneven and the kidneys were small granular and contracted (Fig. 29). The colour of the kidneys ranged from pale yellow to red. Microscopically, fibrous tissue proliferation was marked. The tubules were dilated and there was desquamation of the degenerated epithelial cells into the lumen forming granular and cellular casts. In some areas, uniform glassy pink stained hyaline casts were seen inside the lumen. There was infiltration in the interstitium with many mononuclear cells and macrophages (Fig. 30 and 31). Vascular changes were also noted significantly. Glomeruli revealed severe degenerative changes and there was calcium deposition around the glomerular and tubular basement membranes (Fig. 24). Presence of calcium was confirmed by staining with Alizarin red-S (Fig. 32). Out of the ten cases of subacute and chronic interstitial nephritis, five animals had thickening of the capillary basement

membranes of the glomeruli while, one animal showed thickening of the capillary basement membranes as well as hypercellularity of the glomeruli. Bacterial isolation was made in seven cases which included four *Staphylococcus aureus* two *E. coli* and one *Proteus sp.* Urine samples were examined in five cases. Of these, three cases had albuminuria and four cases revealed the presence of granular and hyaline casts.

In three cases of chronic interstitial nephritis, which were referred from the Veterinary Hospital, Mannuthy, details regarding haematology and serum biochemical values were obtained. There was a significant reduction in the hemoglobin and total erythrocyte counts, the values of haemoglobin being 10.4, 12.2 and 9.6 g per cent and those for total erythrocyte count being 3.68×10^6, 3.23×10^6 and 2.86×10^6 millions per cubic mm. The Blood Urea Nitrogen (BUN) and creatinine levels were significantly increased. The values were 94, 100.41 and 113.48 mg per cent and 8, 15 and 12 mg per cent for BUN and creatinine respectively. Potassium level was significantly elevated, values being 5.52, 6.55 and 8.03 mEq/ lit. in each of the three cases.

4.2.2.4.3. Pyemic nephritis

Two cases of pyemic nephritis with multiple pin point greyish-white foci diffusely spread over the cortex of the kidney were recorded. Microscopically, these areas revealed a central eosinophilic material surrounded by neutrophils and few lymphocytes. A definite capsule was not present (Fig.33). *Staphylococcus aureus* was isolated from the liver and kidney of one case in which similar pyemic foci were seen in the liver also. The tubular epithelial cells revealed hydropic degeneration and necrosis in the adjacent areas. In both the cases, the glomeruli revealed hypercellularity.

4.2.2.4.4. Abscess

A case of renal abscess was recorded in the kidney. The abscess was whitish, 0.5 - 1 cm in size, just beneath the cortex. Calcified material in the abscess gave a gritty feeling when the parenchyma was cut. Microscopically, a calcified abscess was seen just below the capsule with a definite fibrous tissue encapsulation (Fig. 34). The tubular epithelial cells showed hydropic degeneration and desquamation into the lumen in some areas.

4.2.2.5. Other disorders

4.2.2.5.1. Hydronephrosis

A case of unilateral hydronephrosis was observed in a dog. The right kidney was almost double the size of the left kidney and appeared like a bag with fluid inside. On incision, it was found that the hydronephrotic kidney had widened calyces which gave a cystic appearance. There was atrophy and thinning of the cortex (Fig. 35). Histologically, there was cystic dilatation of the tubules, fibrous tissue proliferation, hypercellularity and degeneration of the glomeruli and infiltration with lymphocytes and macrophages in the interstitium (Fig.36). There was partial occlusion with a stone in the urethra in this case.

4.3. Microbiological studies

A total of 17 bacterial isolations were obtained from 14 animals. Of these, 14 isolates were obtained from 11 animals which had mild to severe inflammatory changes in the liver or kidney or both while, only three isolations were obtained from animals showing

necrotic changes in the liver. The bacterial isolates obtained were

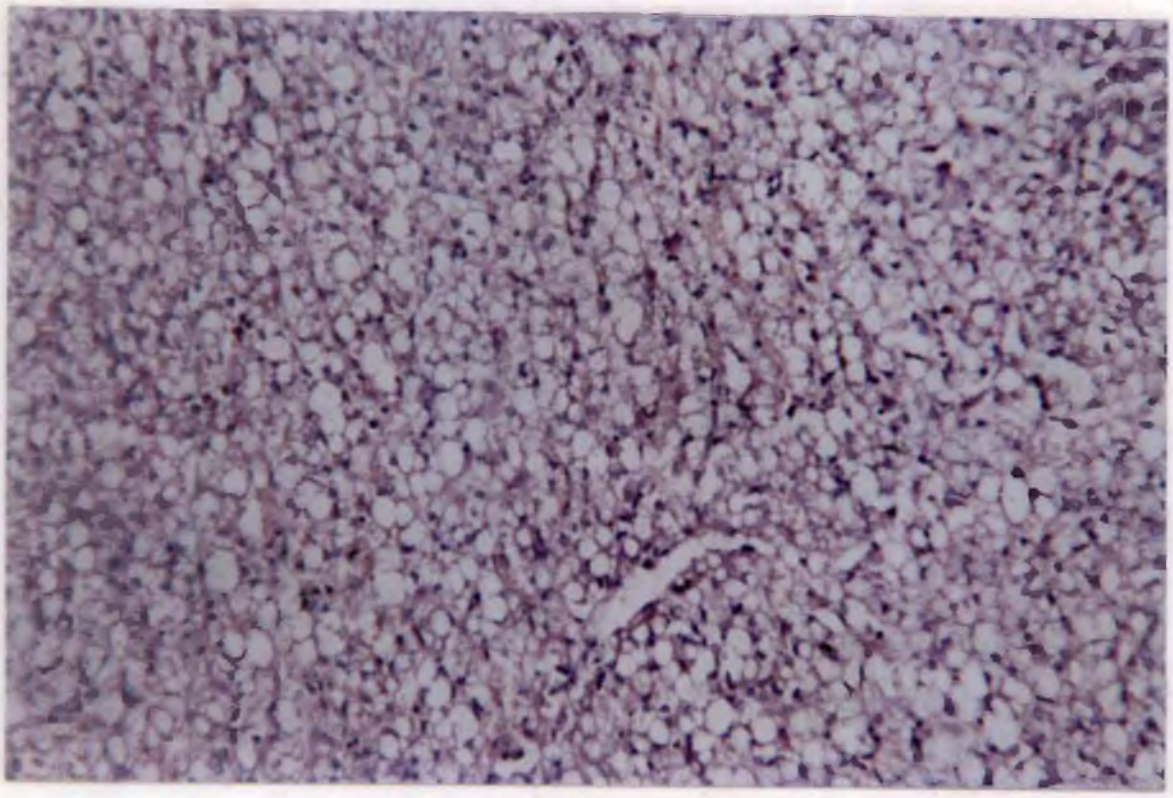
Liver alone	-	*E. coli* (3)
Kidney alone	-	*Staphylococcus aureus* (4)
		E. coli (2)
		Pseudomonas aerugenosa (1)
		Proteus sp. (1)
Liver and Kidney	-	*E.coli* (1)
		Staphylococcus aureus (1)
		Enterobacter aerogenes (1)

4.4. Toxicological studies

The lead content estimated in the liver in a suspected case of lead toxicity was found to be 1.2 ppm. This was found to be less than the toxic dose of lead in the liver in dogs.

Fig. 1. Liver: congestion and haemorrhage. (H&E x 250)

Fig. 2. Liver: Fatty change- Diffuse infiltration of fat globules. (H&E x 250)



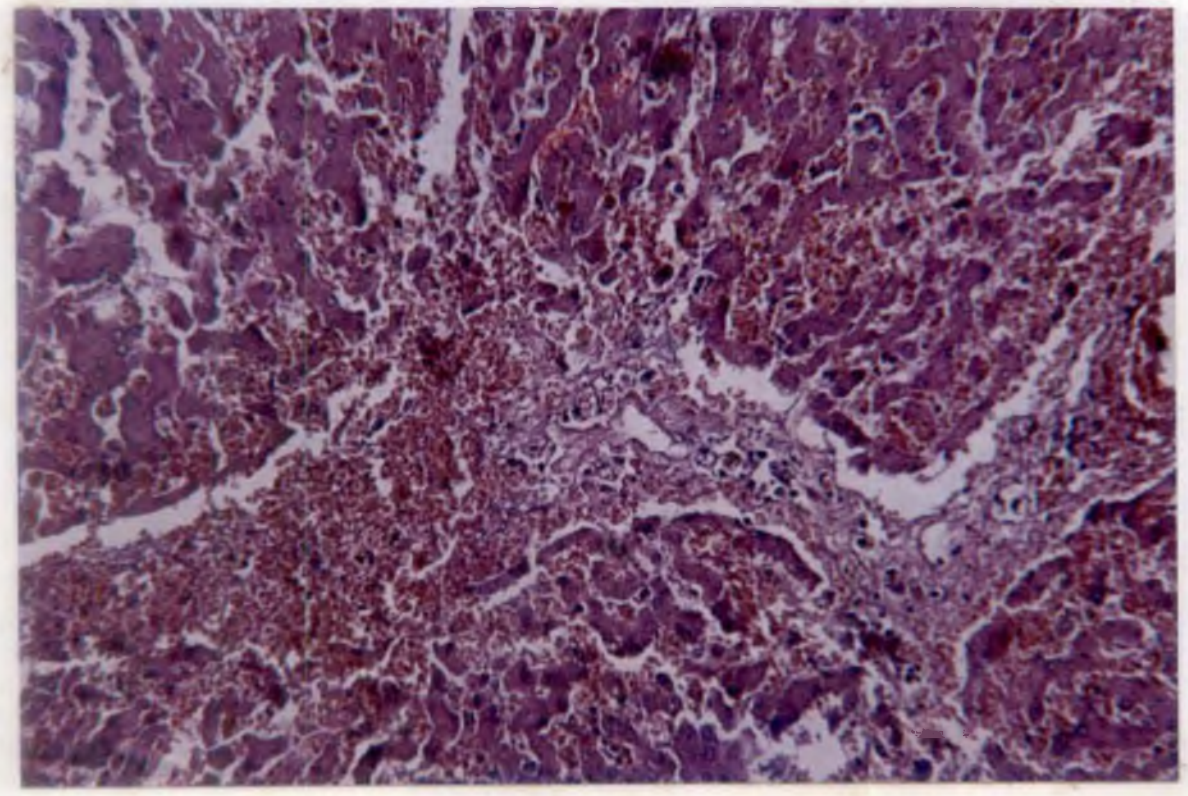
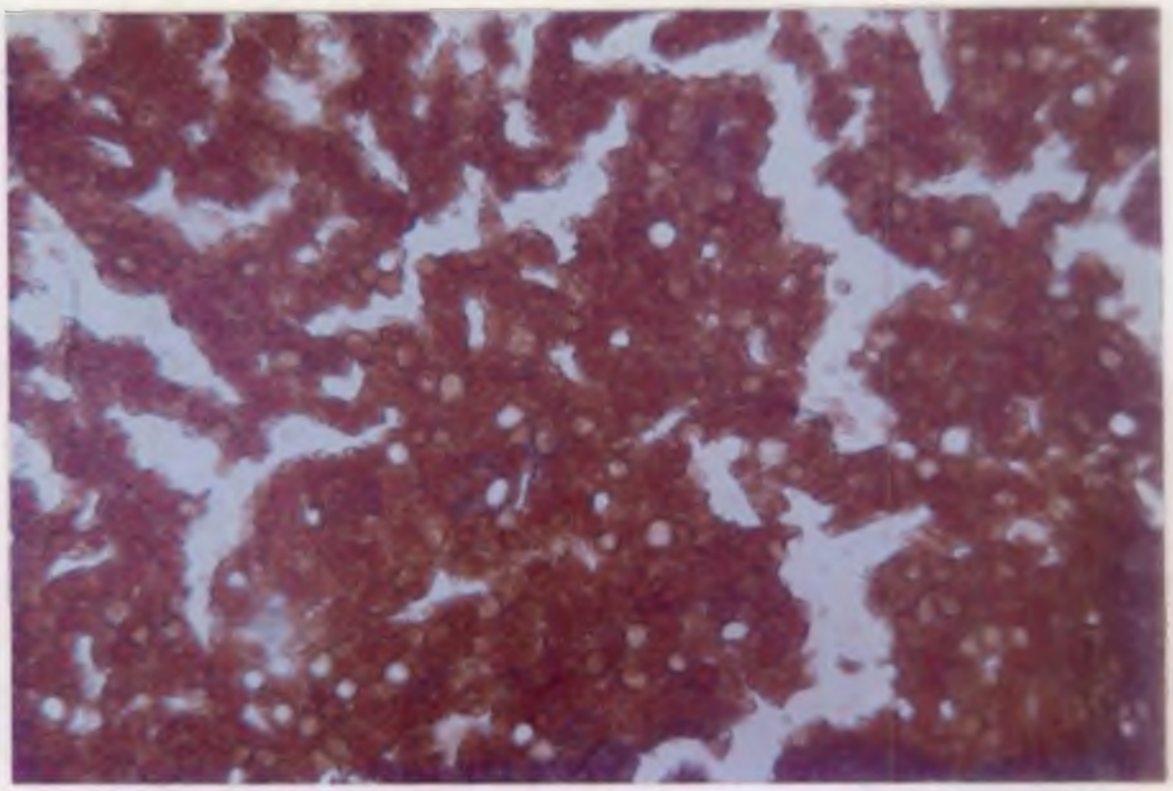


Fig. 3. Liver: Fatty change- Fat globules stained red (Oil red-O x 250)

Fig. 4. Liver: Haemosiderosis- Haemosiderin pigments in the Kupffer cells stained blue- (Pearl's Stain x 250)



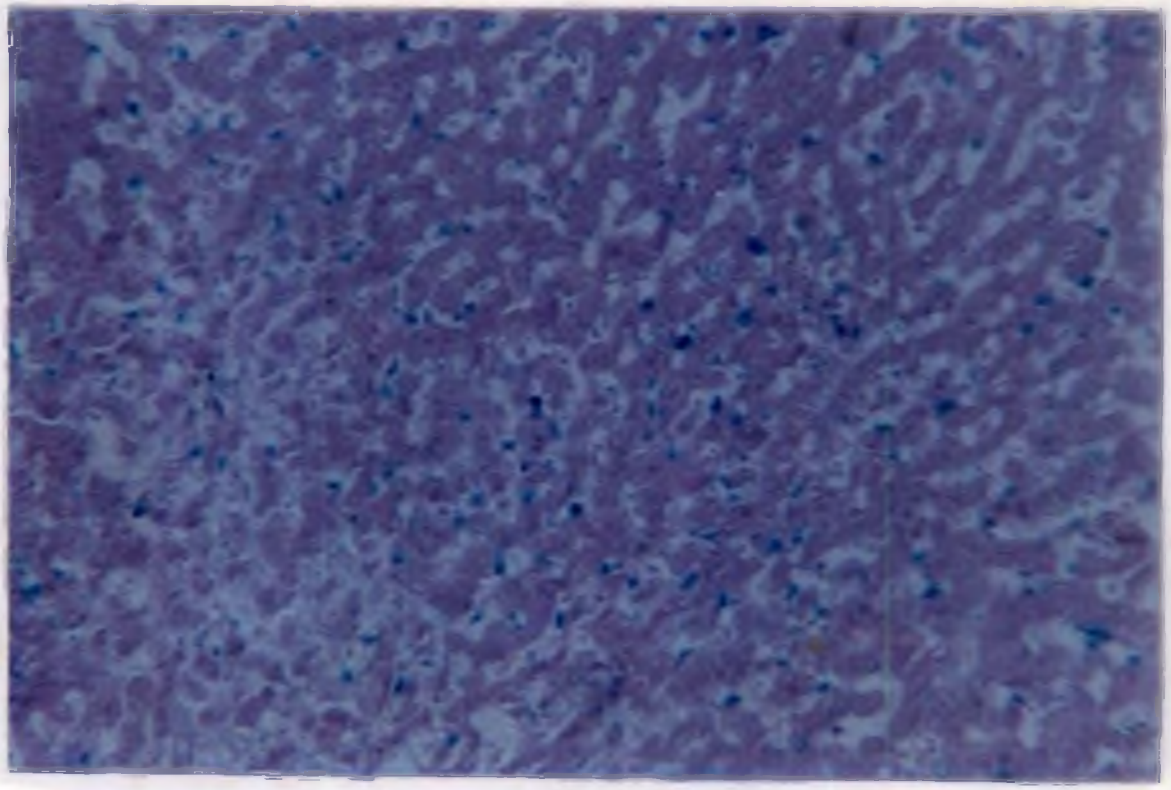
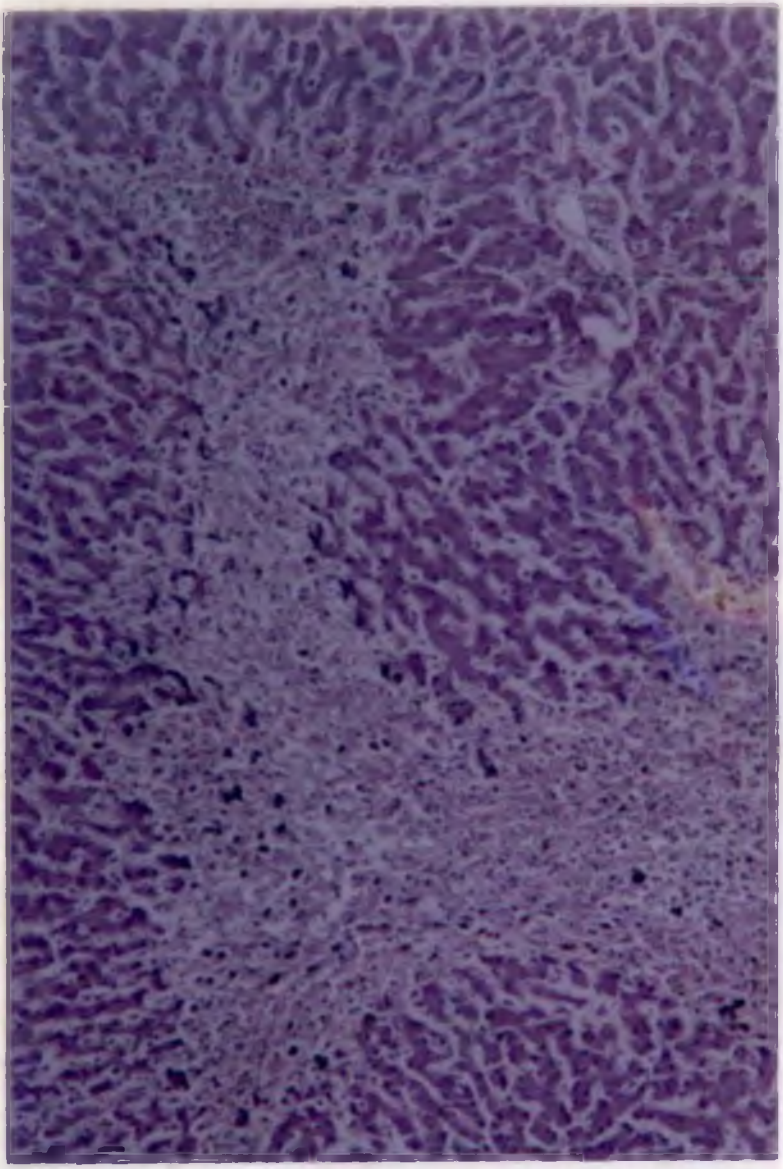


Fig. 5. Liver: Periportal necrosis- Necrosis of hepatocytes in the periportal areas. (H&E x 250)

Fig. 6. Liver: Focal hepatitis- Mononuclear cell infiltration in focal areas distributed randomly in the parenchyma Hydropic degeneration also seen. (H&E x 160).



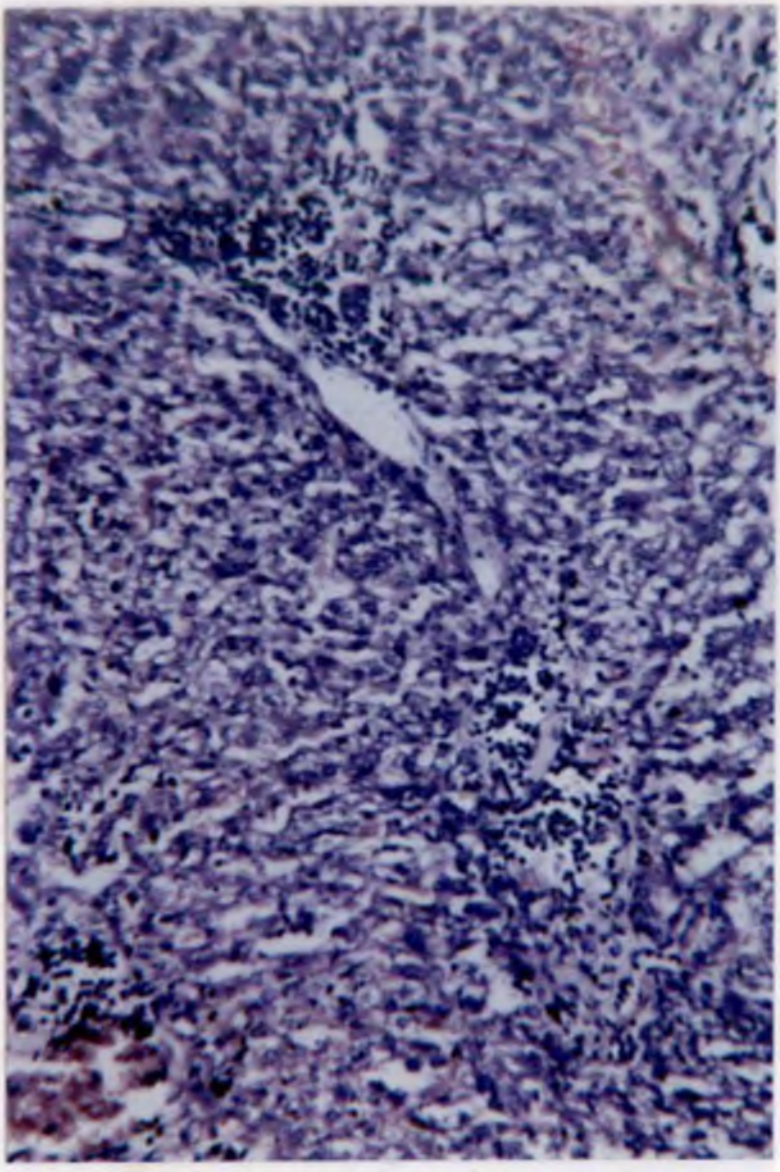
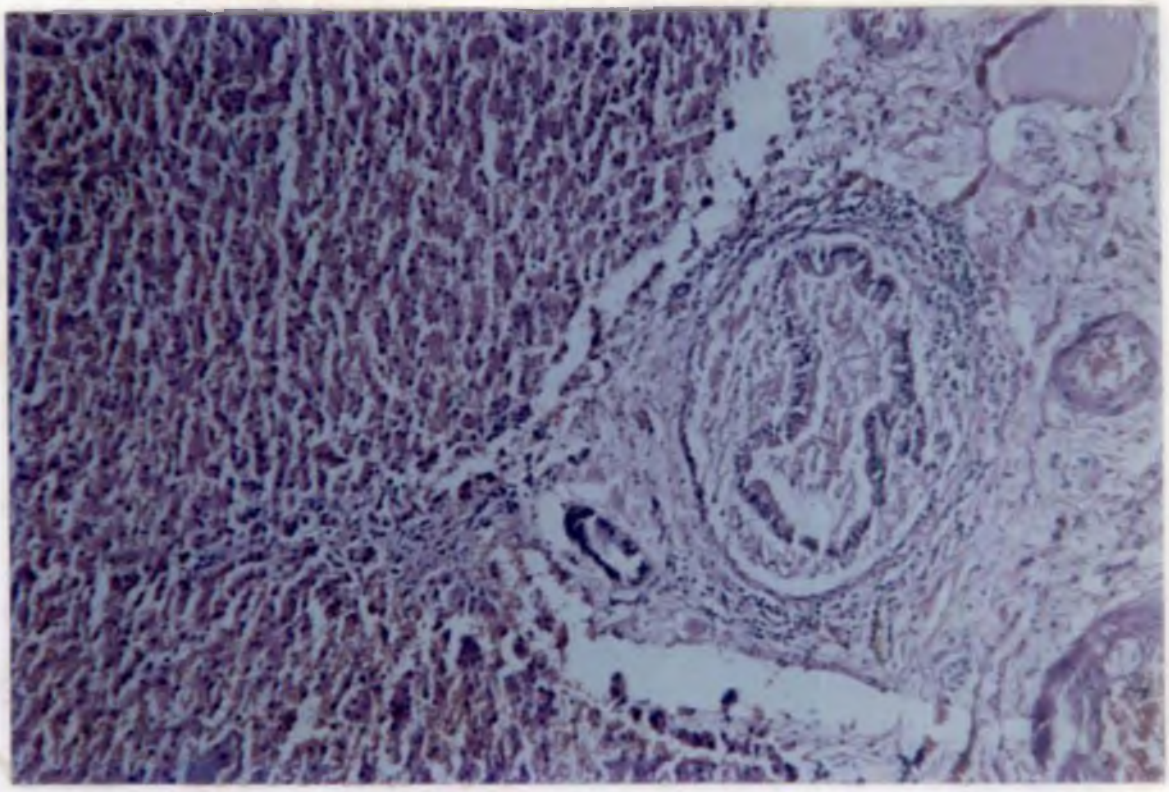


Fig. 7. Liver: Portal hepatitis- Sparse collection of mononuclear cells in the portal area. Connective tissue proliferation also noted. (H&E x 250).

Fig. 8. Liver: Suppurative Hepatitis- Infiltration of neutrophils and sparse number of mononuclear cells. Degeneration and lysis of hepatocytes in the area. (H&E x 160).



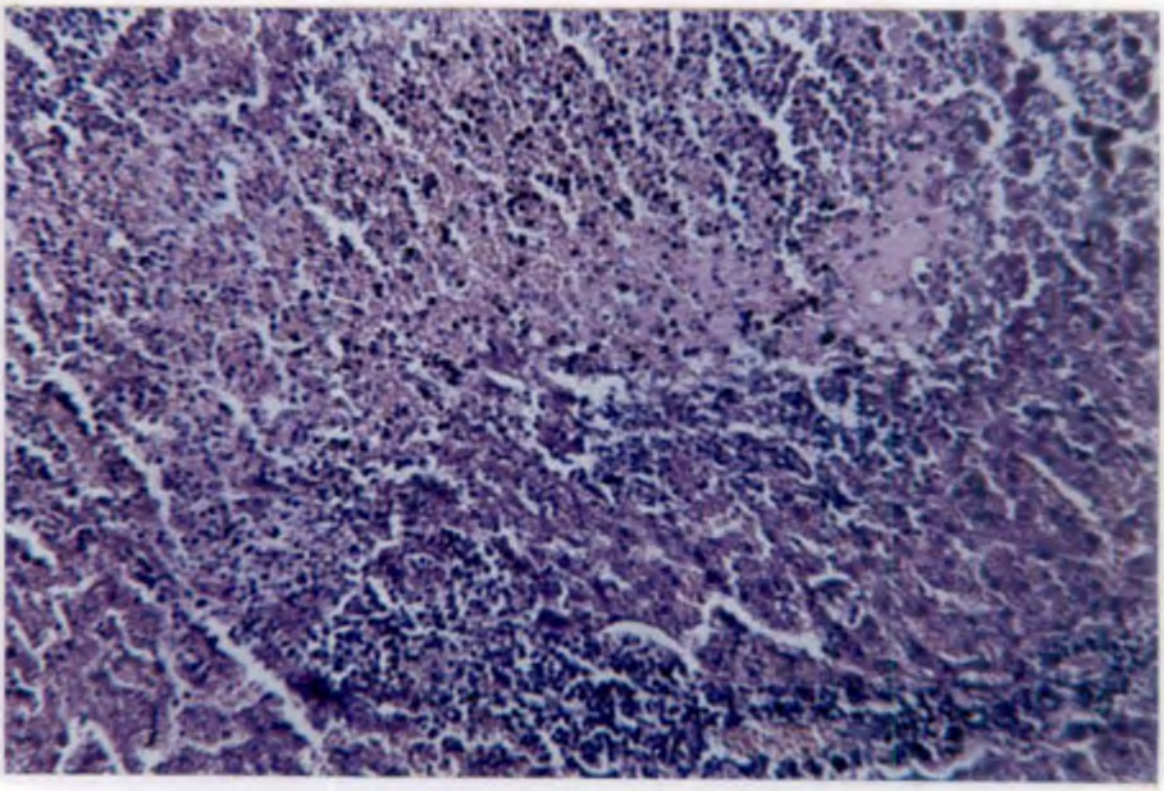


Fig. 9. Liver: Cirrhosis- Nodularity of the surface.

Fig. 10. Liver: cirrhosis- Proliferating fibrous tissue resulting in pseudolobulation. Hepatocytes showing vacuolar changes and necrosis. Infiltration with sparse number of of mononuclear cells. (H&E x 250).

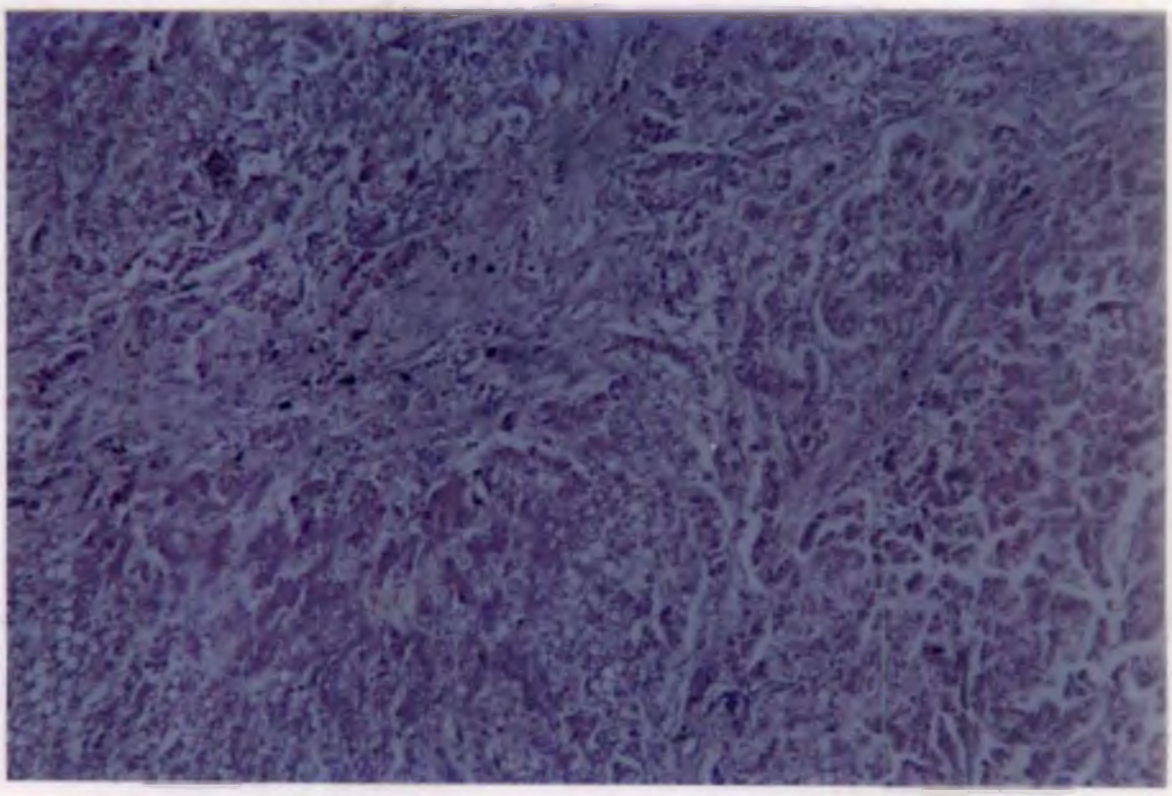
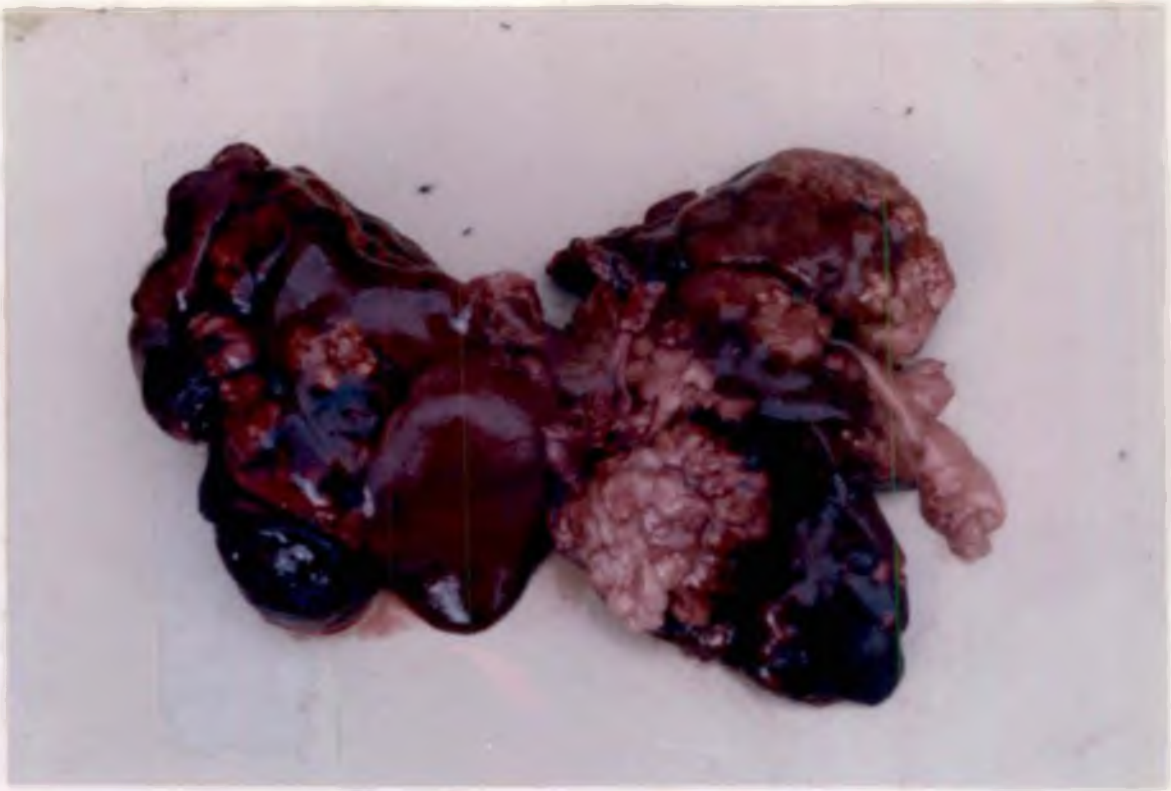


Fig. 11. Liver: Cholangiocarcinoma- Multiple whitish nodular growths of varying sizes diffusely distributed in the parenchyma.

Fig. 12. Liver: Cholangiocarcinoma- Islands of neoplastic cells separated by prominent fibrous tissue. (H&E x 250).



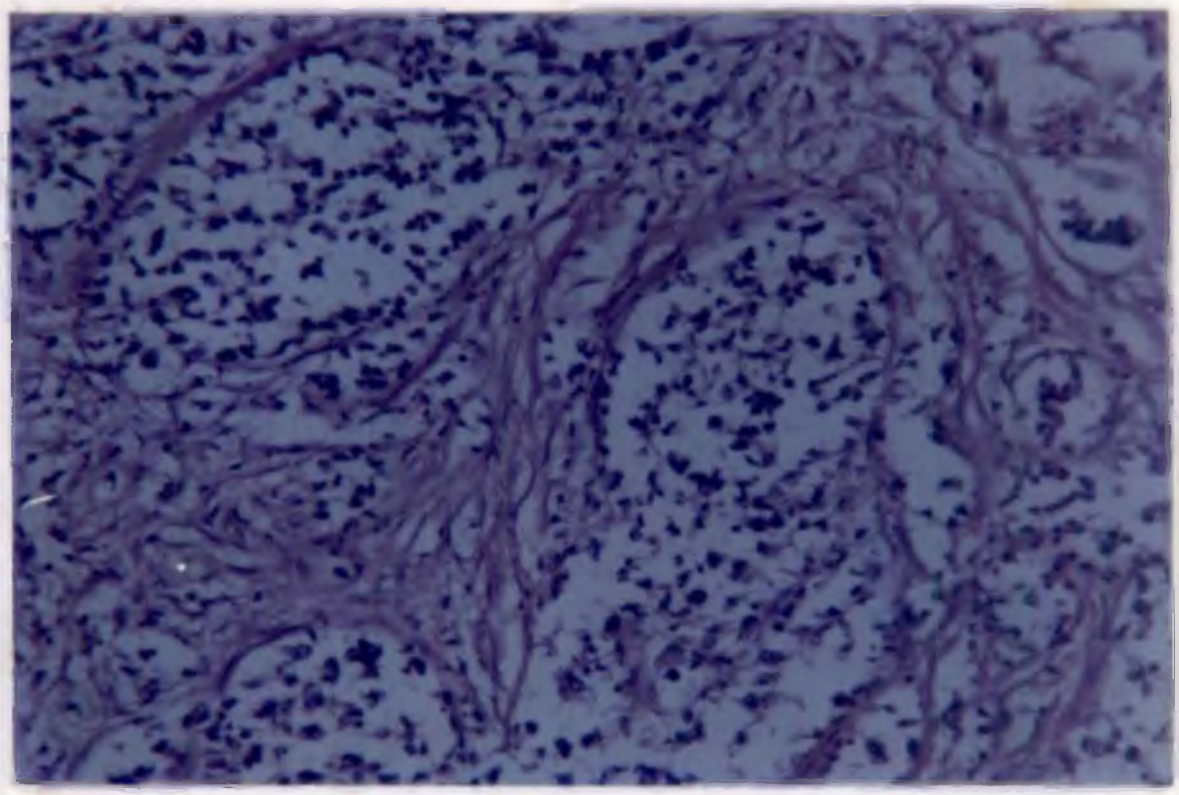
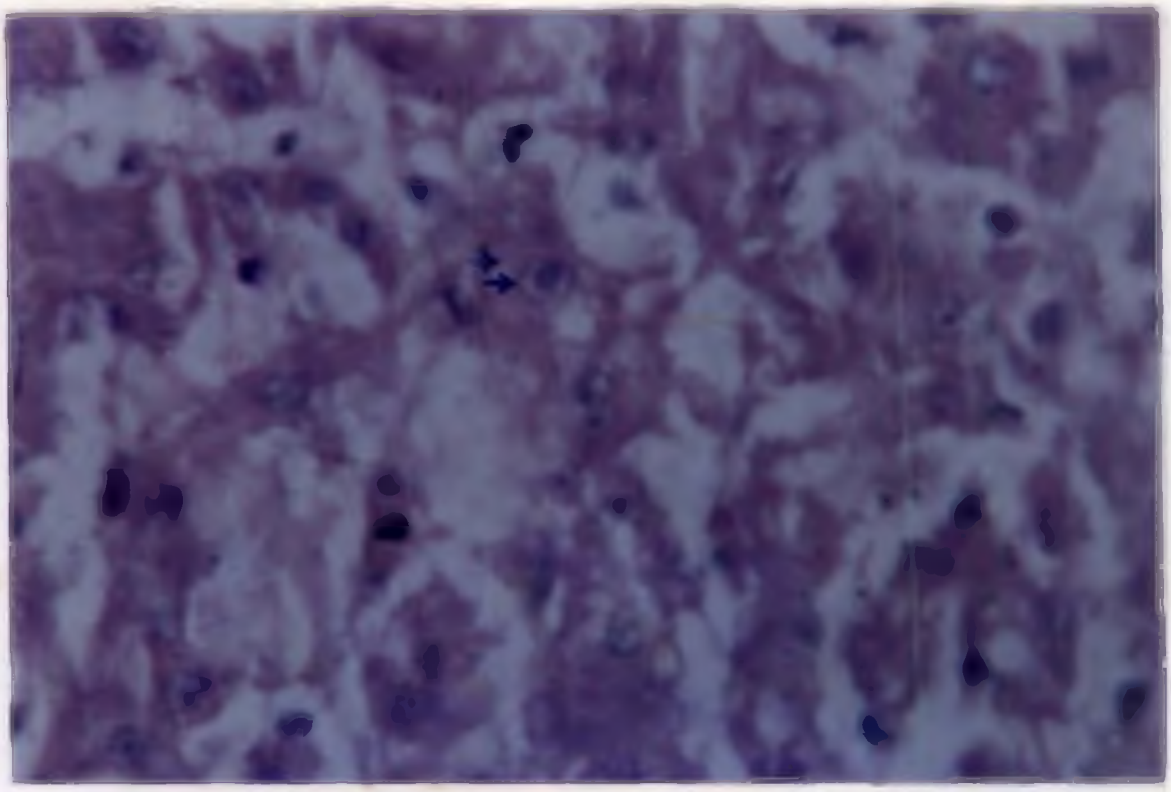


Fig. 13. Liver: Basophilic intranuclear inclusions in the hepatocytes with a clear halo around (arrow). (H&E x 1000).

Fig. 14. Kidney: Basophilic intranuclear inclusions in the glomerular epithelial cells with a clear halo around (arrow). (H&E x 1000).



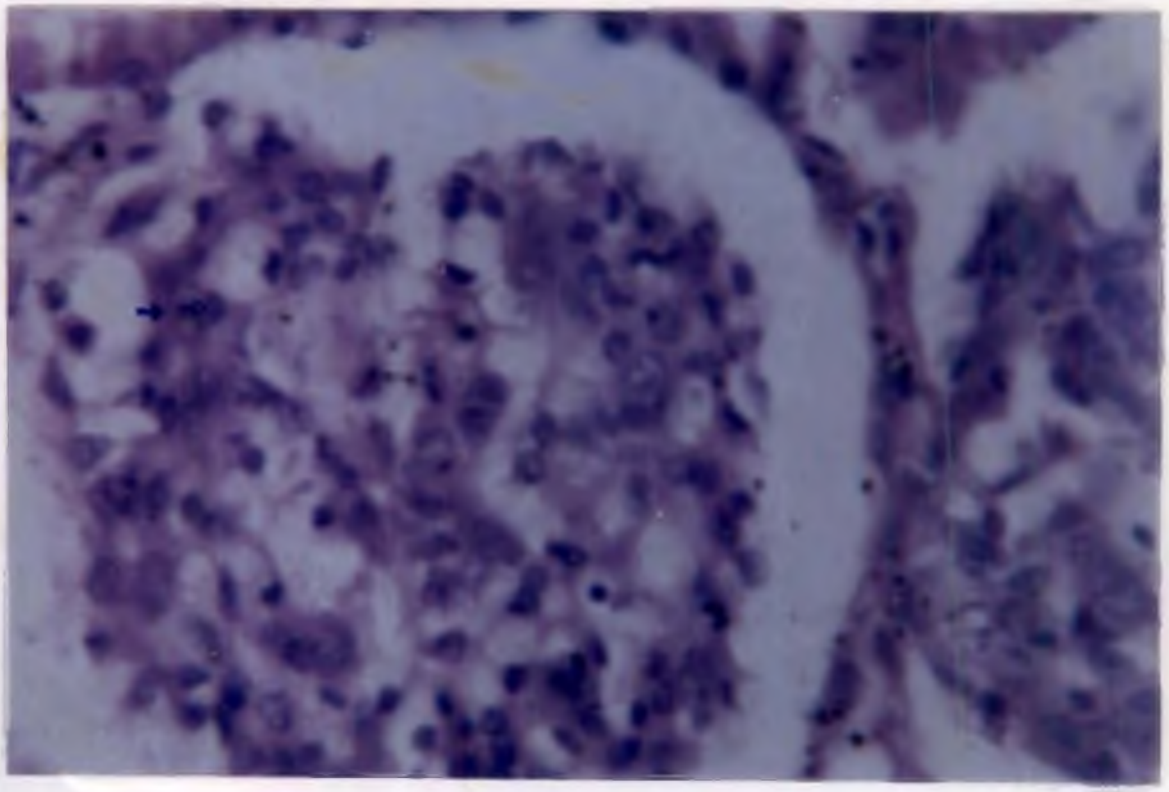


Fig. 15. Liver: Adhesion of diaphragm with liver on its dorsal surface.

Fig. 16. Liver: Adhesion of diaphragm with liver. Connective tissue stained red and muscle fibres stained purple. (PTAH x 250).

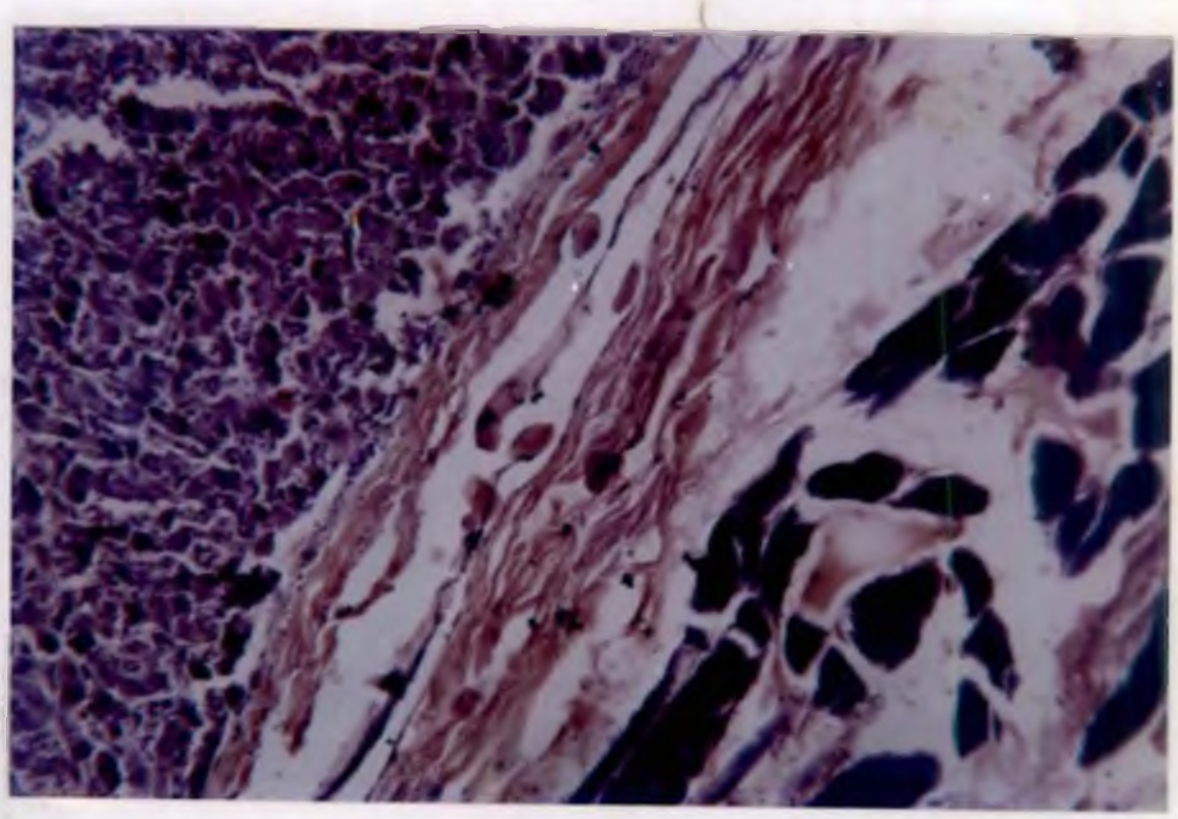
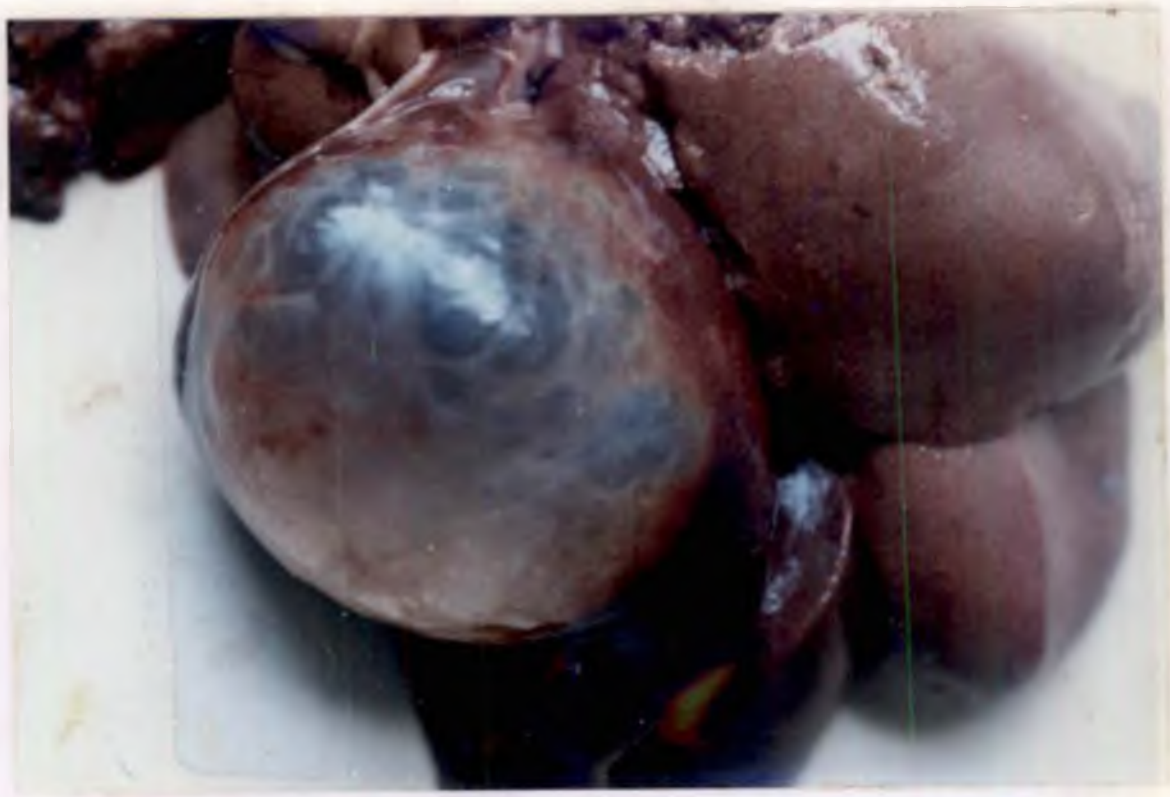


Fig. 17. Liver: A large cyst on the dorsal lobe of the liver with clear fluid inside.

Fig. 18. Liver: Cyst- Lined by cuboidal epithelial cells (arrow). Adjacent hepatocytes showing atrophy and degeneration. (H&E x 250).



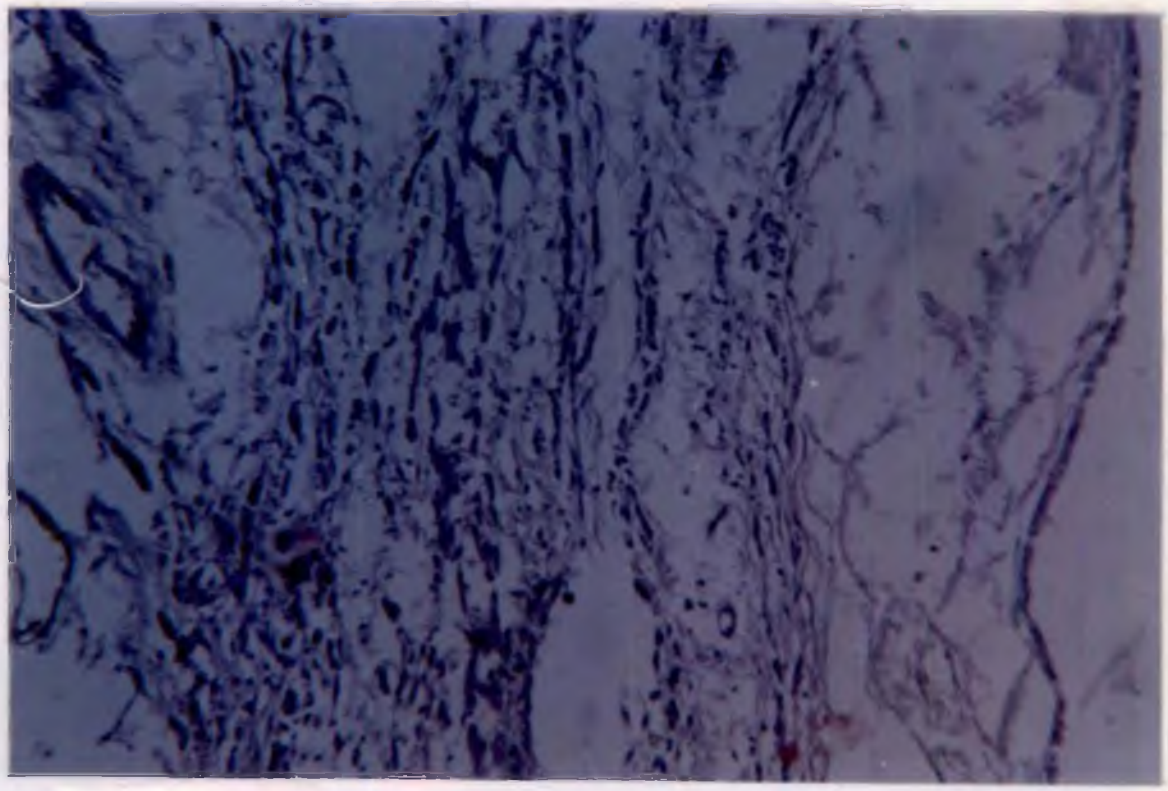


Fig. 19. Kidney: Haemorrhage in a suspected case of snake bite. Extensive areas of haemorrhages in the medullary regions.

Fig. 20. Kidney: Haemorrhage- Extensive haemorrhages in the interstitium and glomeruli. Severe degeneration and necrosis of the tubules. (H&E x 250).

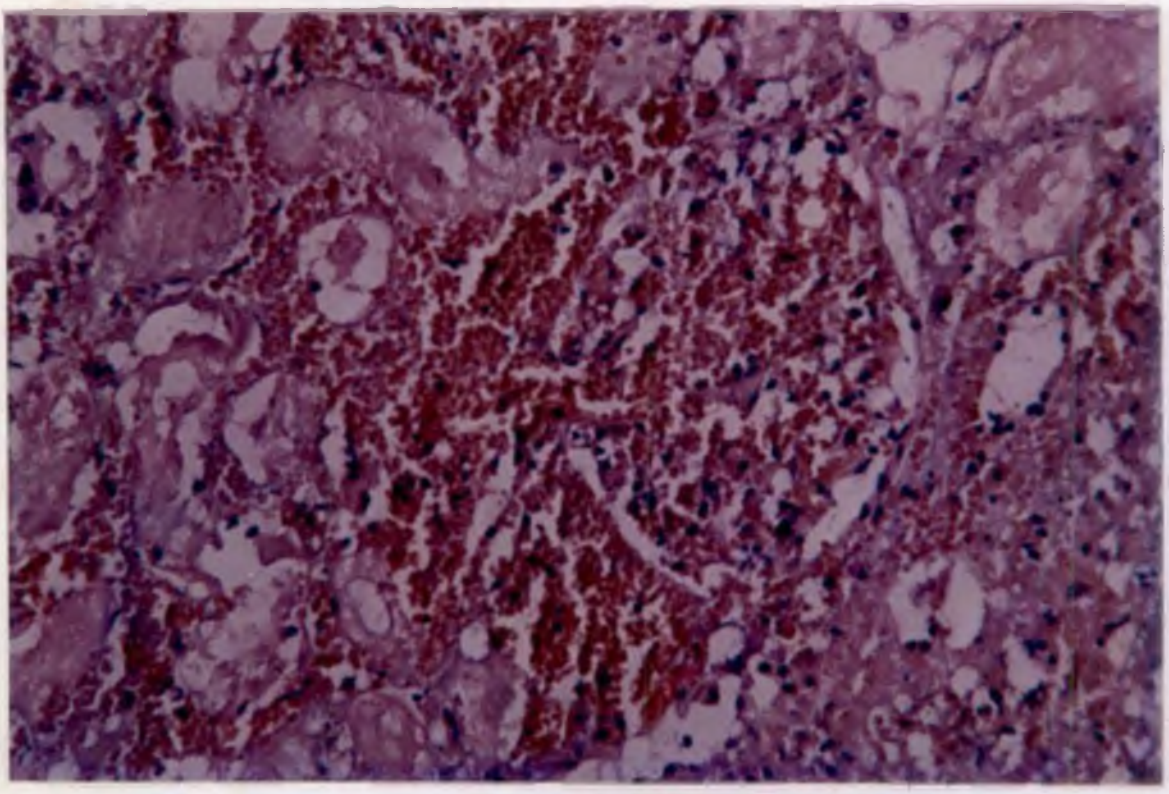
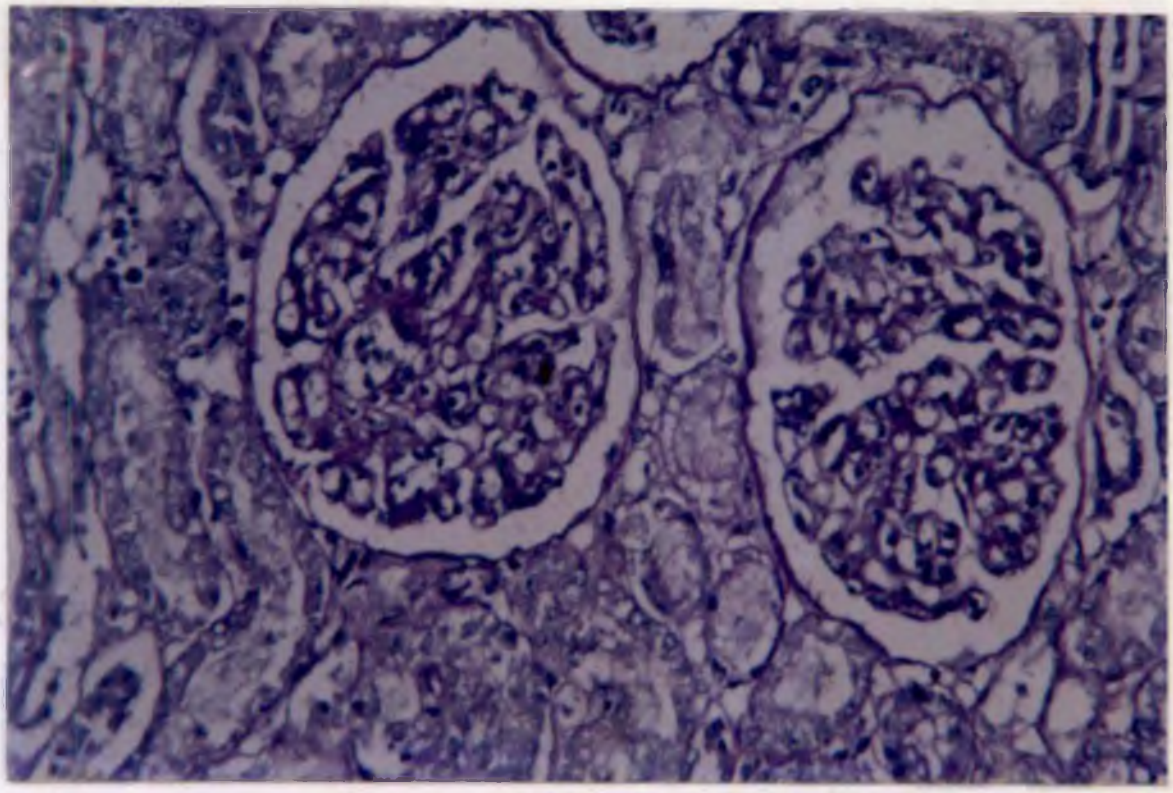


Fig. 21. Kidney: Membranous nephropathy- Diffuse thickening of the capillary basement membranes. (PAS x 400).

Fig. 22. Kidney: Proliferative glomerulonephritis- Hypercellularity due to mesangial cell proliferation in the glomeruli. Obliteration of Bowman's space. Pyknosis of the nuclei in the adjacent tubules. (H&E x 250).



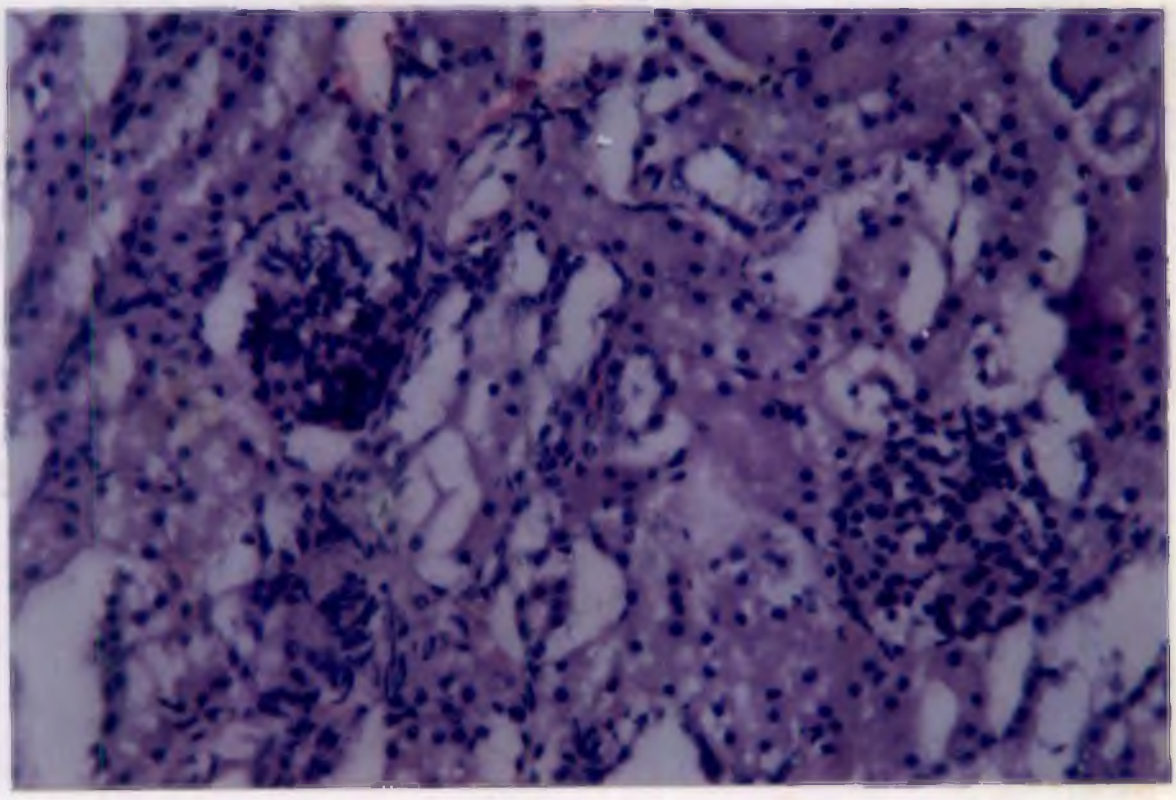
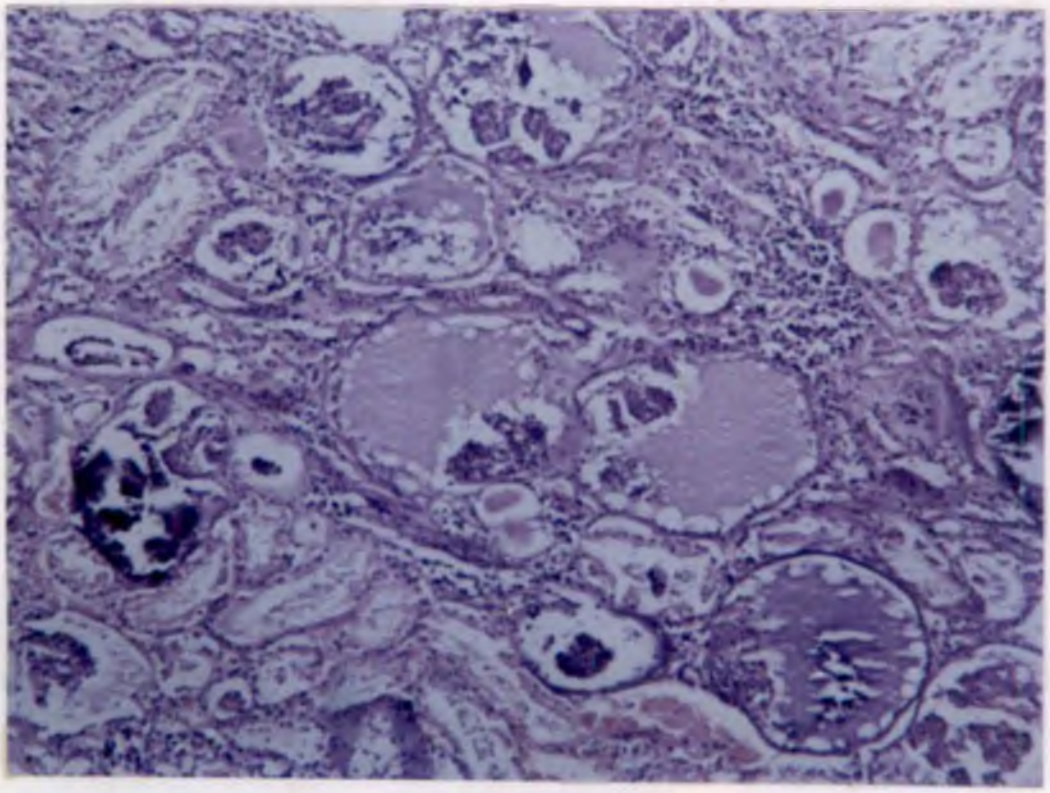


Fig. 23. Kidney: Proliferative glomerulo nephritis- Hypercellularity of glomerular tuft due to infiltration with polymorphonuclear cells. Congestion, haemorrhage and degeneration of tubular epithelium in the adjacent parenchyma. (H&E x 400).

Fig. 24. Kidney: Fragmentation and atrophy of glomeruli, dilatation and exudation into Bowman's space, degeneration of tubular epithelium and infiltration with mononuclear cells into the interstitium. Calcification of the glomeruli. (H&E x 250).



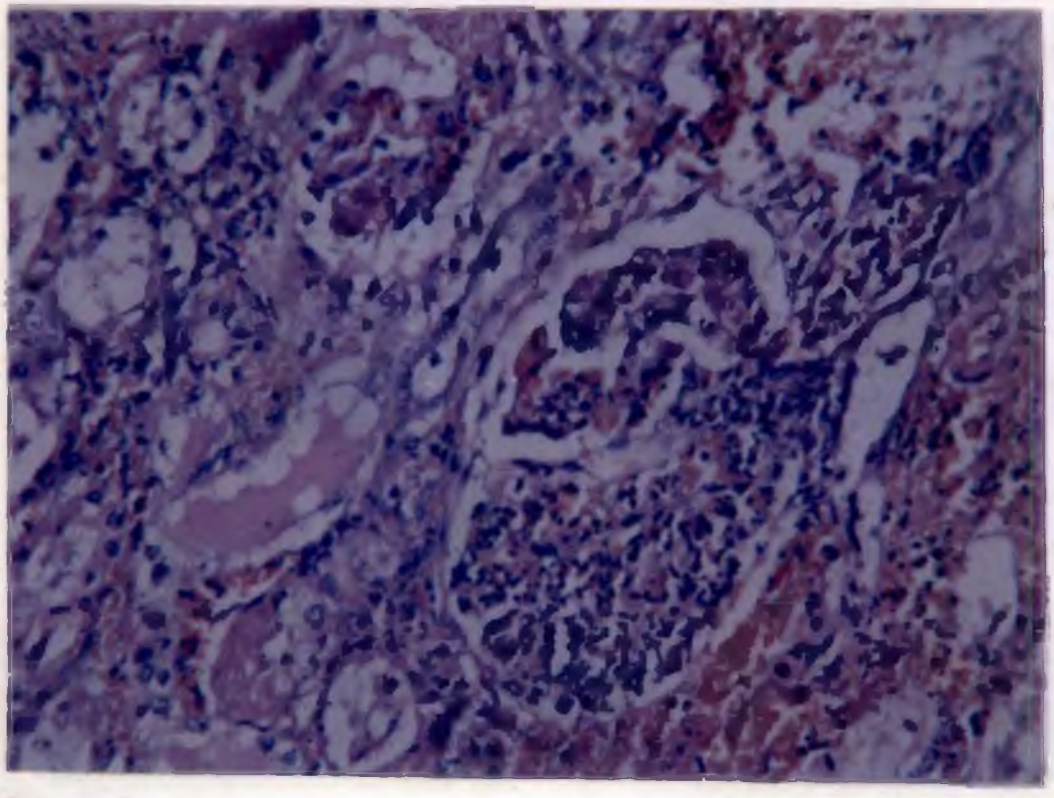
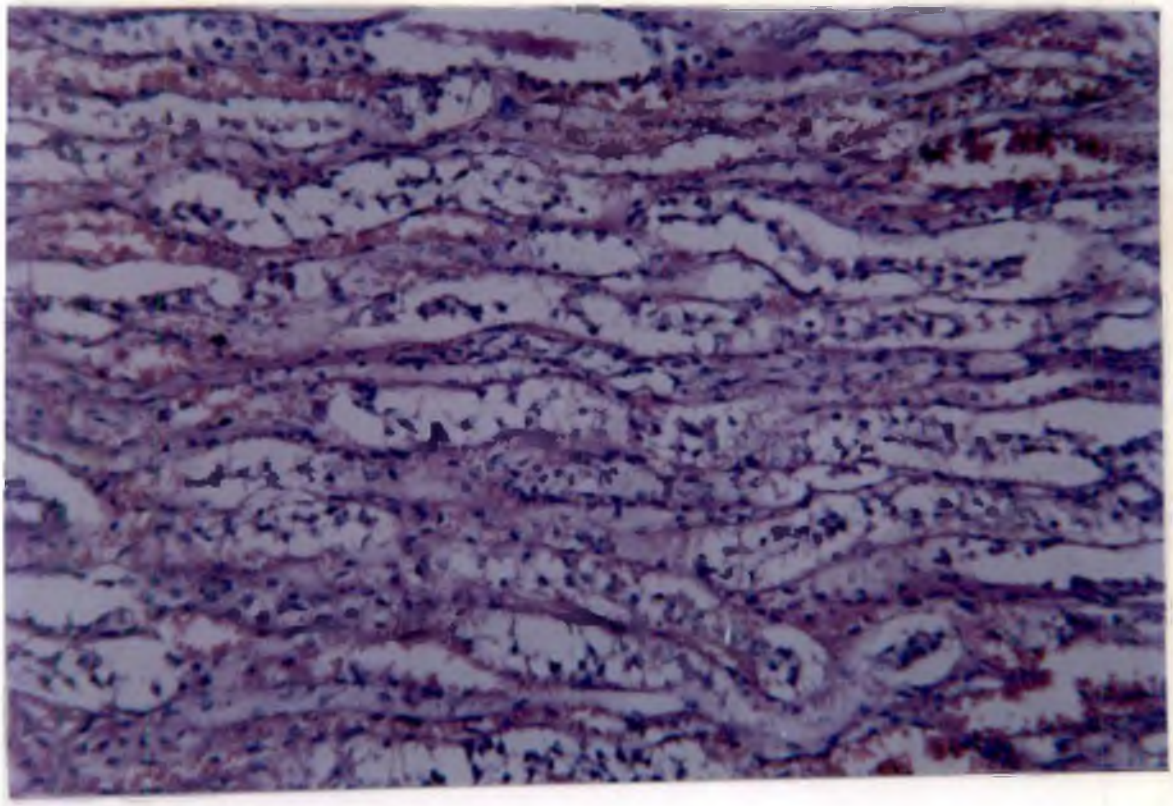


Fig. 25. Kidney: Hydropic degeneration- Clear cytoplasmic vacuolations displacing the nuclei towards the luminal side, congestion of the interstitial capillaries. (H&E x 250).

Fig. 26. Kidney: Hyaline casts in the lumen of tubules, stained pink with PAS. Degeneration and lysis of tubular epithelium. (PAS x 250).



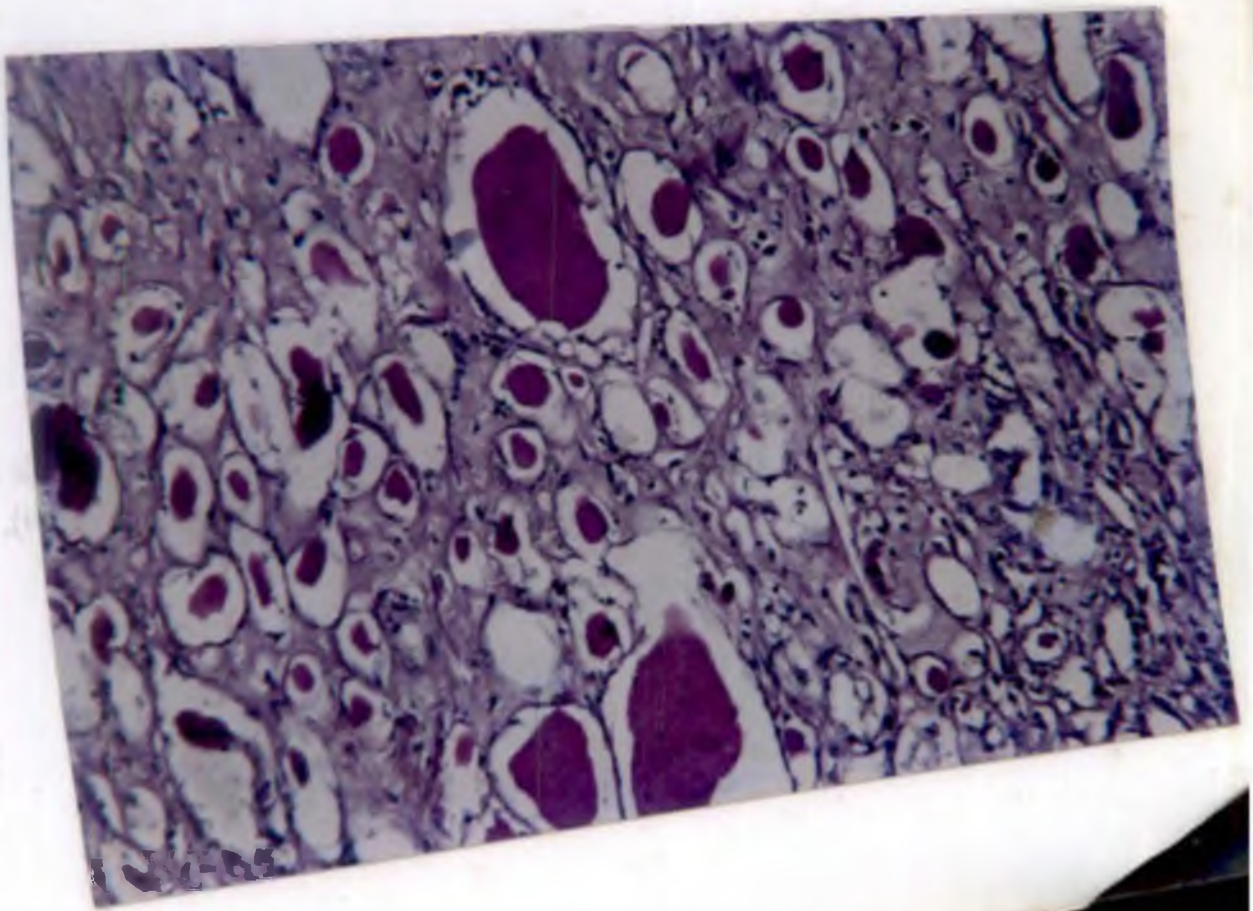
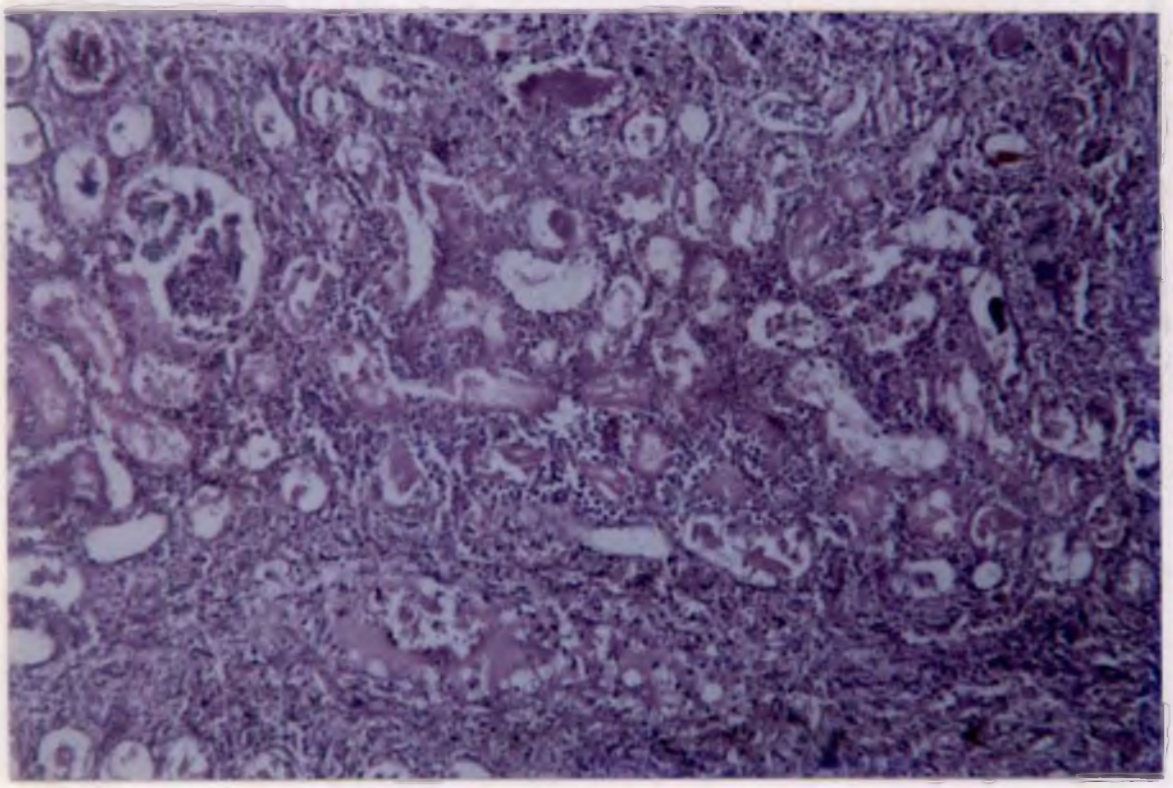


Fig. 27. Kidney: Pyelonephritis- Radiating streaks of polymorphonuclear infiltrates in interstitium. Congestion of interstitial capillaries, degeneration and necrosis of tubular epithelium also seen. (H&E x 250).

Fig. 28. Kidney: Acute interstitial nephritis- Diffuse infiltration with polymorpho nuclear cells in the interstitium and glomerular tuft. Degeneration and necrosis of the tubular epithelium. (H&E x 160).



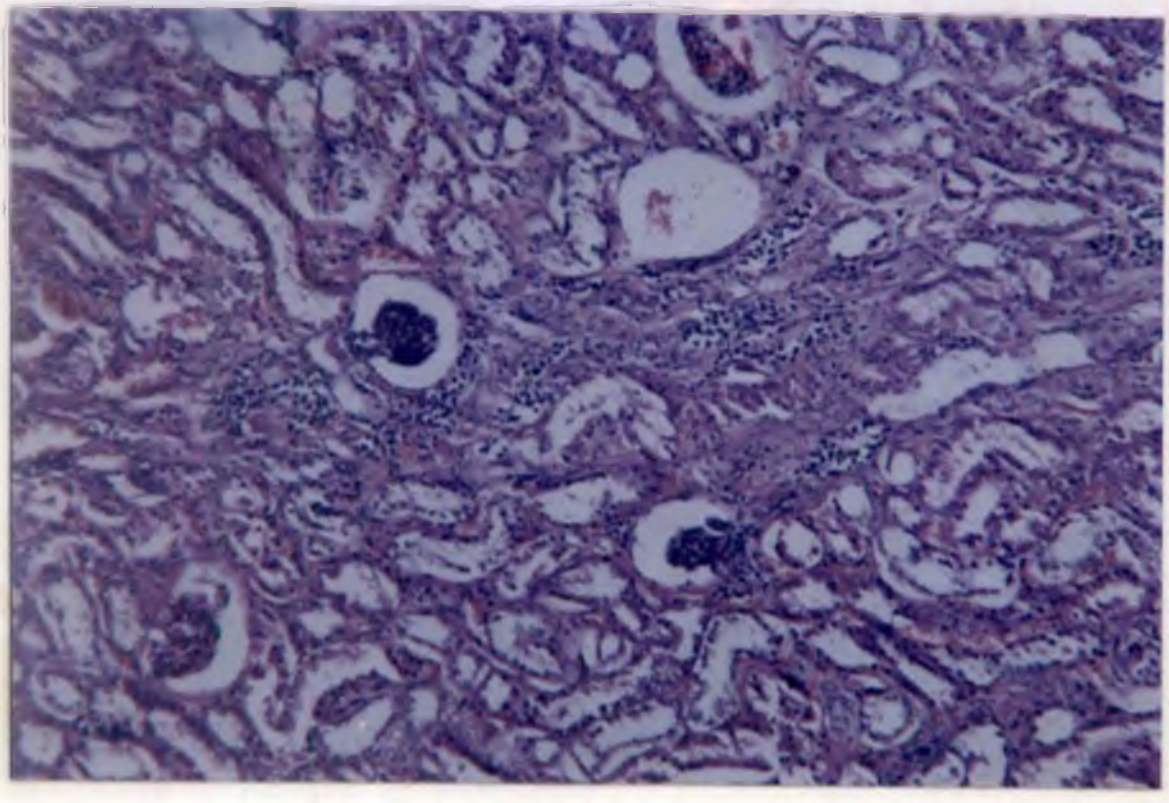


Fig. 29. Kidney: Chronic interstitial nephritis- Pale discolouration with nodularity of the surface.

Fig. 30. Kidney: Chronic interstitial nephritis- Severe fibrous tissue proliferation replacing most of the tubules. Diffuse infiltration with mononuclear cells in the interstitium . Dilatation of existing tubules . (H&E x 400).

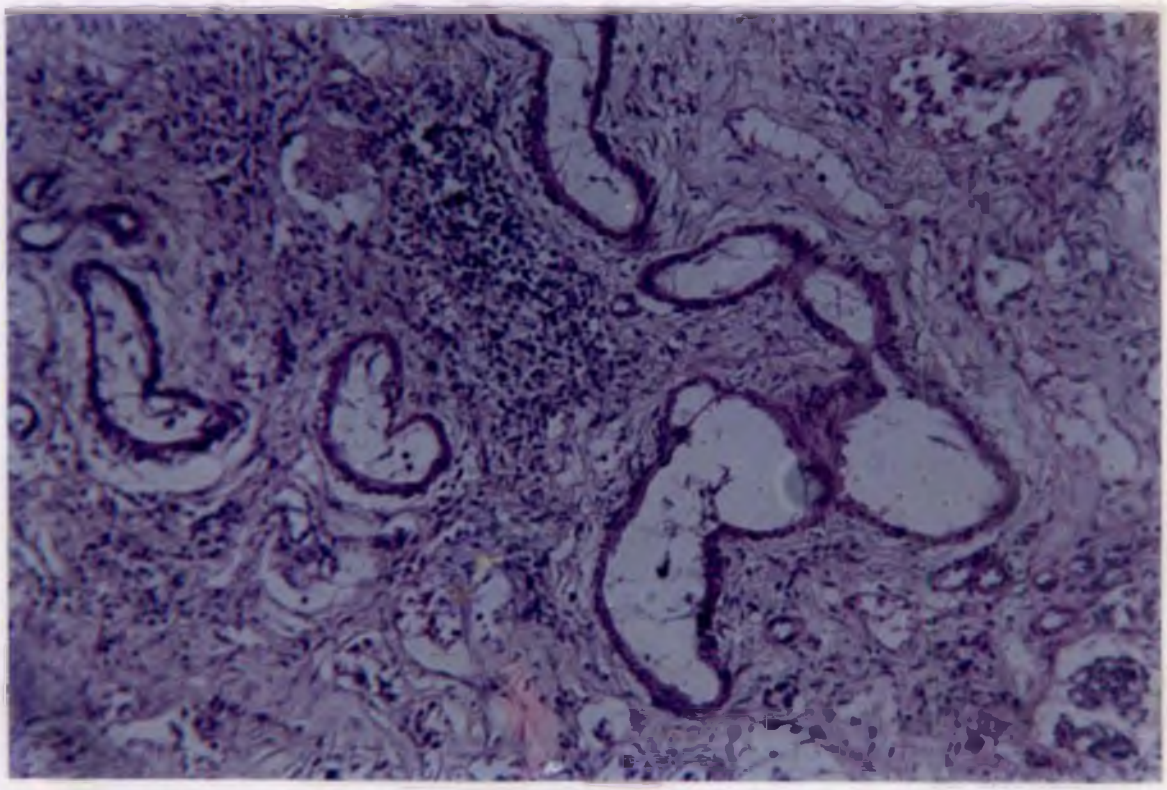
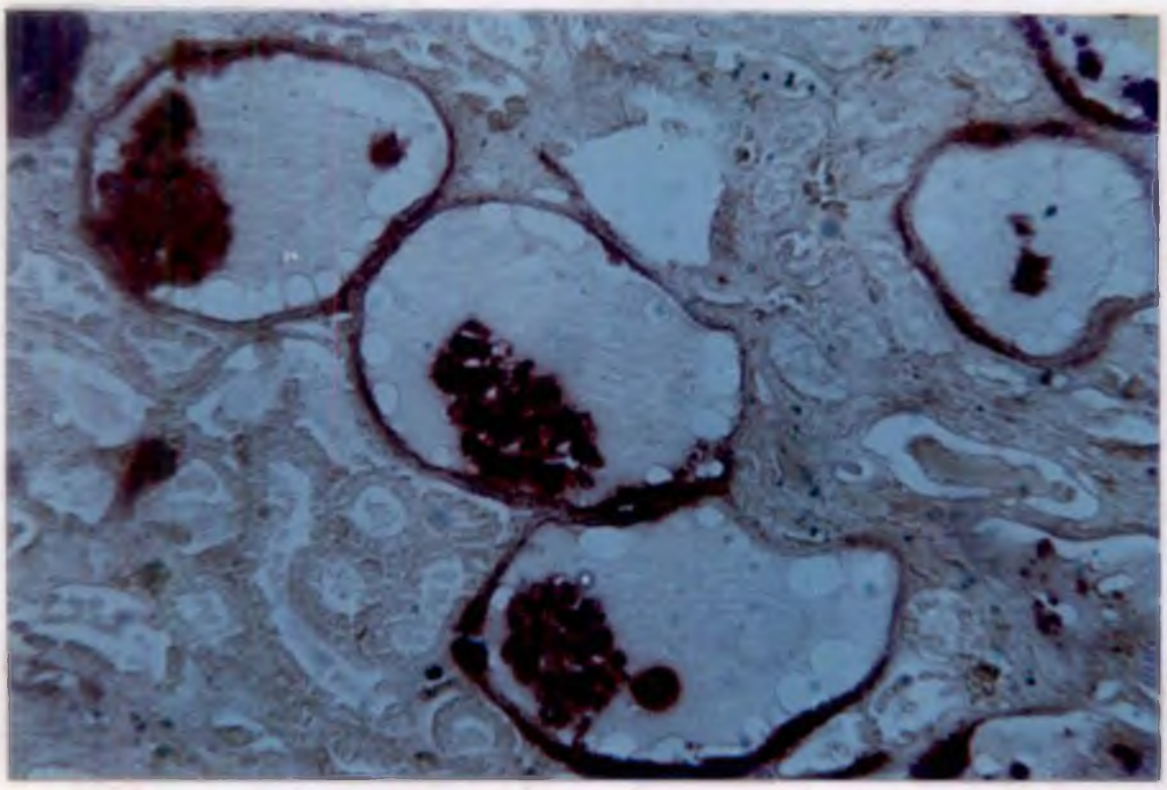


Fig. 31. Kidney: Chronic interstitial nephritis- Fibrous tissue proliferation and infiltration with mononuclear cells in the interstitium. Degeneration and necrosis of tubules, atrophy and fragmentation of glomerular tuft, dilatation of Bowman's space and thickening of parietal layer. (H&E x 400).

Fig. 32. Kidney: Chronic interstitial nephritis- Calcification of the glomerular tuft and parietal membrane with dilatation of Bowman's space. (Alizarin Red- S x 250).



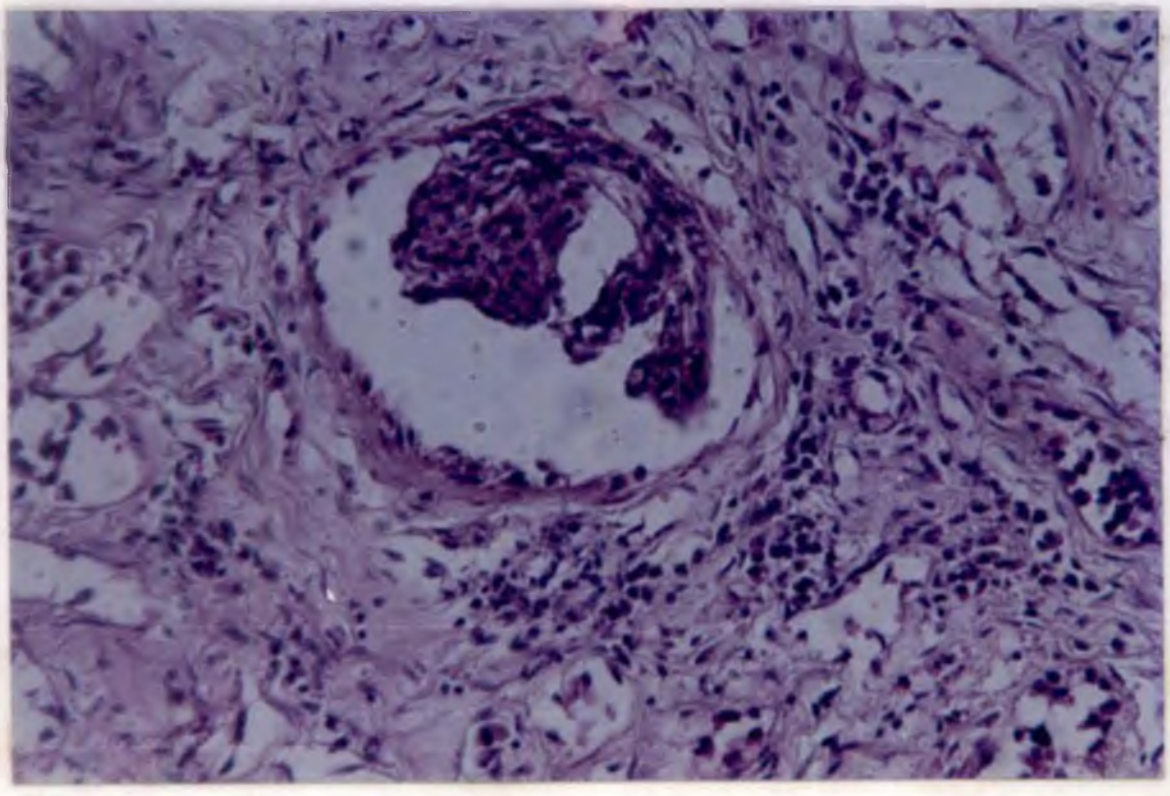
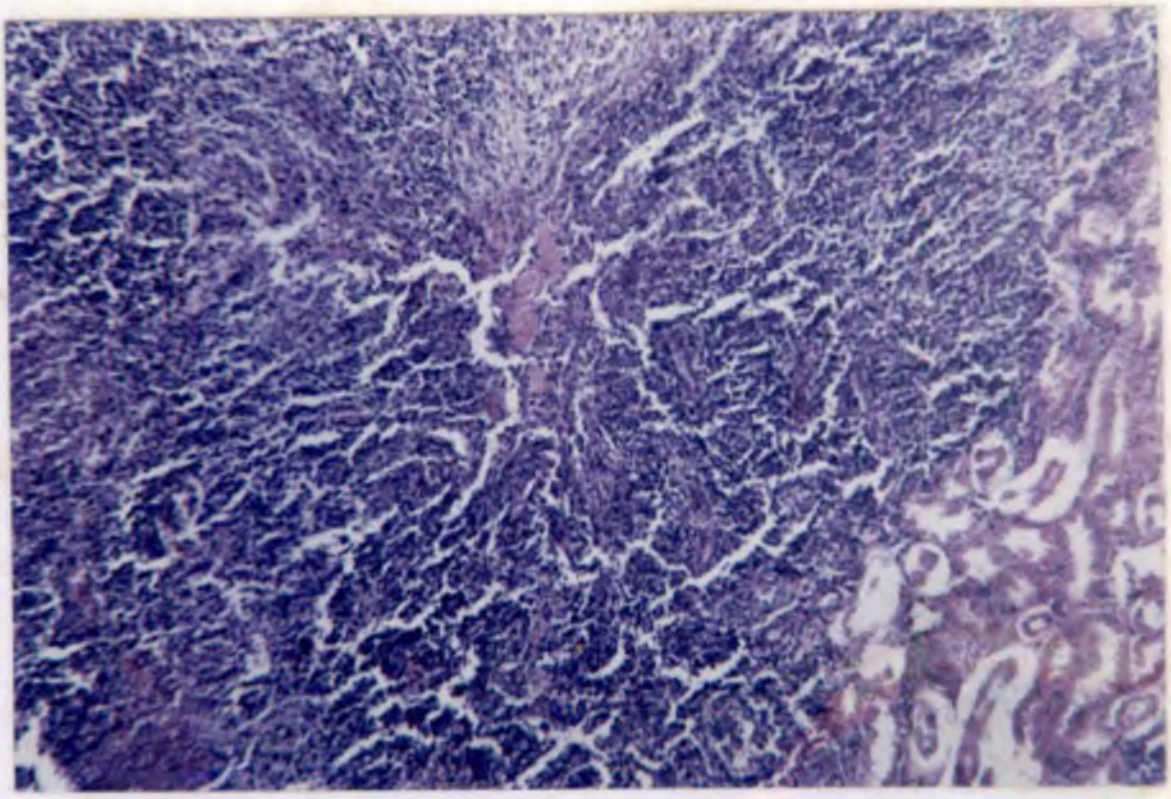


Fig. 33. Kidney: Pyemic nephritis- Focal collection of pus cells and lysis of the parenchyma. Degeneration and necrosis of the adjacent tubular epithelium. (H&E x 250).

Fig. 34. Kidney: Abscess- Calcified encapsulated abscess in the cortex. Degenerative changes in the surrounding parenchyma. (H&E x 160).



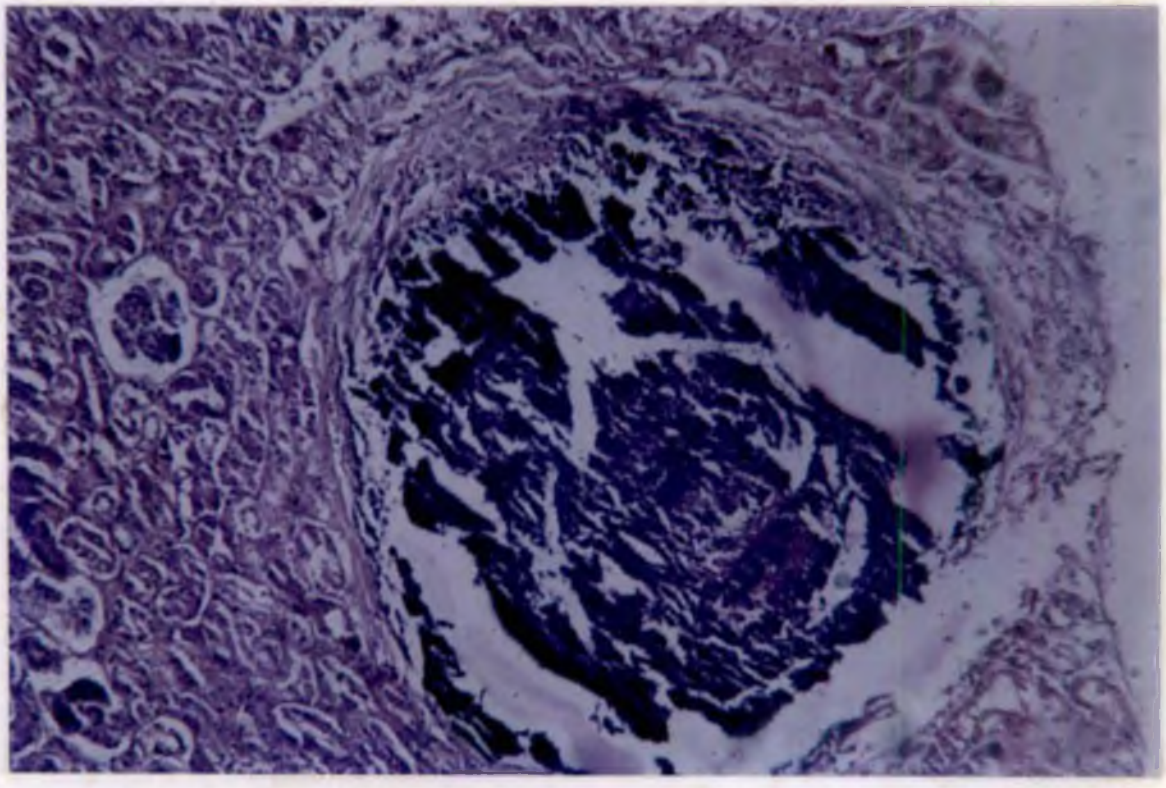
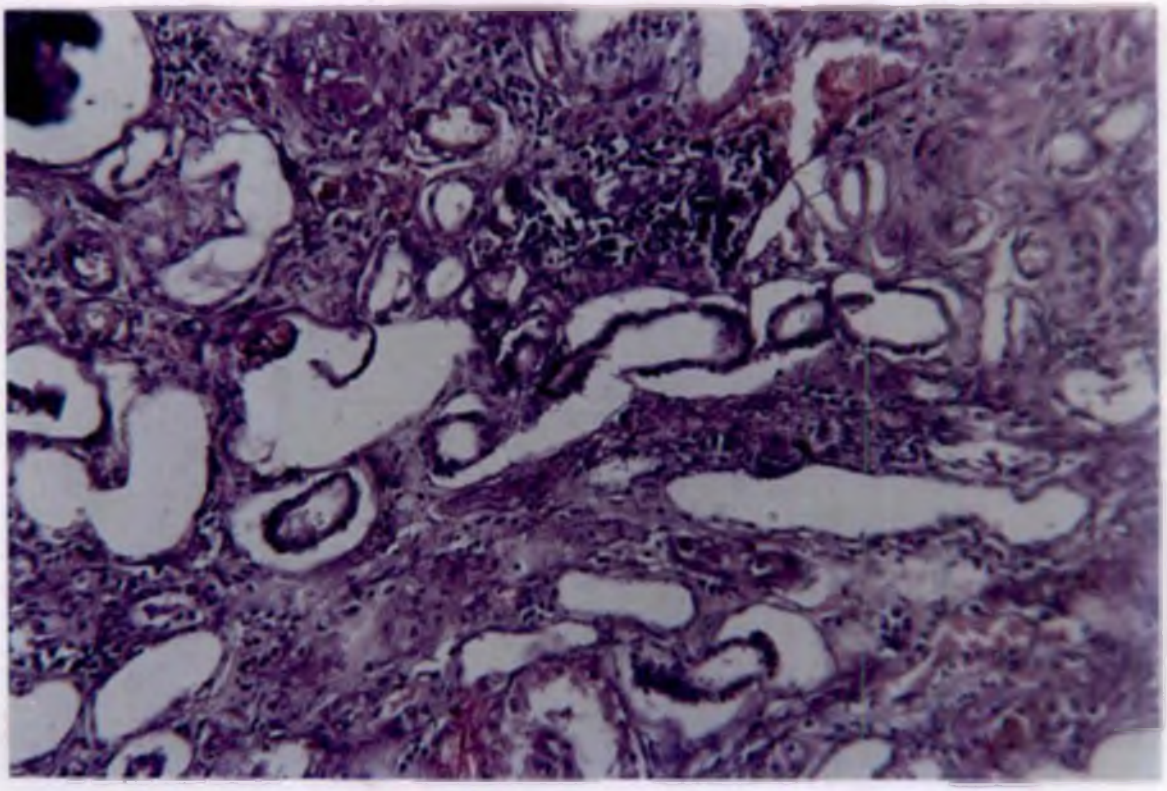


Fig. 35. Kidney: Hydronephrosis- Widening of the pelvis and calyces and thinning of the cortex and medulla.

Fig. 36. Kidney: Hydronephrosis- Dilatation of tubules and Bowman's space, fibrous tissue proliferation and infiltration with mononuclear cells in the interstitium, degeneration and desquamation of tubular epithelium. (H&E x 250).



DISCUSSION

5. DISCUSSION

The present study was undertaken to evaluate the prevalence and nature of pathological disorders of the liver and kidney in canines. This investigation has enabled to catalogue and categorise the various disorders in these organs. The information gathered have made it clear that the disorders of the liver and kidney in canines are much more common than expected.

Analysis of the records available at the Centre of Excellence in pathology for the past five years showed that 75 per cent of cases had lesions in the liver and 82 per cent had lesions in the kidney. A systematic gross and histopathological study carried out in one hundred carcasses of canines brought for autopsy during the period of study also revealed the presence of pathological lesions in the liver and kidney to the magnitude of 76 per cent and 85 per cent respectively, suggesting a similar pattern over these years. This also indicated a higher incidence of kidney lesions over liver lesions in dogs.

Among the liver disorders, it was found that animals more than five years of age and animals between one to three years of age were most affected, followed by animals between three to five years of age and less

than one year of age. There was no significant difference between the sexes with respect to the liver lesions, supporting the view of Strombeck and Guilford (1991). Among breeds, it was found that German Shepherds had a higher percentage of incidence followed by non-descripts. Out of the hundred livers examined, moderate to severe necrosis was seen in 15 cases and mild to severe hepatitis was seen in 19 cases. Strombeck and Guilford (1991) reported an incidence of eight per cent necrosis and 18 per cent hepatitis. Fibrosis, cirrhosis and bileduct proliferation were seen in 9, 2 and 5 cases respectively. Similarly, Strombeck and Guilford (1991) reported an incidence of four per cent fibrosis, two per cent cirrhosis and three per cent bile duct proliferation. The pattern of distribution of liver lesions in the present study were in agreement with the findings of Strombeck and Guilford (1991). One case each of cholangiocarcinoma, hepatic cyst and the adhesion of diaphragm with liver were also observed in the present study.

Among the kidney disorders, significant difference was not observed in the incidence of renal lesions with respect to different age groups. However, dogs between three to five years of age had a lesser incidence compared to the other age groups. Minkus *et al.* (1994)

also did not observe any relationship between different types of nephropathy and age. However, Kulkarni *et al.* (1997) have reported a higher incidence of renal lesions in dogs above five years of age. It was observed that the percentage of incidence of renal disorders was higher in females compared to males in the over all population presented. This is contradictory to the findings of Kulkarni *et al.* (1997) which states that males have a preponderance for renal disorders. But, in the present study also, it was found that, males had a higher tendency for glomerulonephritis and tubulo-interstitial nephritis when they were considered separately. Among breeds, it was found that German Shepherds had a higher incidence followed by non-descript dogs which is in accordance with the findings of Kulkarni *et al.* (1997).

Among the kidney lesions, glomerular changes were predominant. Fifty nine out of the 85 cases with kidney lesions had glomerular changes. Studies conducted by Muller-Peddinghans and Trautwein (1977a) revealed that 91 out of 101 dogs with or without clinical signs of renal disorders examined at necropsy had glomerulopathy. Rouse and Lewis (1975), after examining 71 stray dogs for evidence of GN, confirmed the fact that GN is more common than previously recognised.

Eighteen cases among the 32 cases of GN were of proliferative type, indicating a higher incidence of PGN. This is in concurrence with the findings of Sabri and Hayward (1981). Proliferative glomerulo nephritis was predominant in animals less than three years of age, while membranous and membrano-proliferative nephritis were common in animals above three years of age. These findings are in agreement with those of Muller-Peddinghans and Trautwein (1977b), who have also reported that proliferative nephritis is common in younger and middle aged dogs and membranous and membranoproliferative nephritis is common in older dogs. Lewis (1976) evaluated the result of 50 cases of GN in dogs and found that males had increased tendency for PGN and females for membranous nephropathy. In the present study, it was found that males had increased predilection for PGN, but there was no difference between the sexes with respect to the percentage of incidence of membranous nephropathy. Grauer and Dibartola (2000) did not observe any sex prediliction in dogs with GN.

Interstitial nephritis was predominant among the various types of tubulo-interstitial nephritis. Acute interstitial nephritis was seen in animals less than five years of age. All cases of sub acute interstitial

nephritis were seen in dogs above three years of age and all cases of chronic interstitial nephritis were seen in older dogs (above five years of age). Similar findings were reported by Minkus *et al.*(1994). The present study showed an increased predilictiion for interstitial nephritis in males. Two cases of pyelonephritis were seen and both were in females. Preponderence of females for pyelonephritis has been suggested by Smith *et al.* (1972) and Sastry (1983a). It has been suggested by Sastry (1983a) that more than 55 per cent of all dogs autopsied have some form of tubulo-interstitial nephritis. However, in the present study, tubulo-interstitial nephritis was seen in only 16 cases out of the 100 cases examined, while GN was seen in 32 cases. Non-discripts had higher incidence of tubulo-interstitial nephritis and glomerulonephritis. Most of these were stray dogs which have a higher chance of getting exposed to various pathogens and toxicants.

Most of the dogs with lesions in the liver and kidney had the history of anorexia, vomition, respiratory distress and nervous signs. Vomition in hepatic and renal disorders occur due to the direct stimulation of chemoreceptor trigger zone in the brain by the toxins not cleared by the liver and kidney

(Rothuizen and Meyer, 2000). Gastritis could also have resulted in vomition in cases where uremic lesions were seen. Nervous signs in liver disorders arise due to inadequate metabolism of aromatic amino acids. Strombeck and Guilford (1991) suggested that increased concentration of ammonia as a result of improper detoxification in liver disorders lead to neurotoxicity. Polzin *et al.* (2000) reported that 65 per cent of the dogs and cats with renal failure have neurological manifestations. Hypocalcemia as a result of altered calcium pumps in renal disorders and brain ischemia due to hypertension were the causes suggested by them. Respiratory distress in hepatic and renal disorders could have been due to pulmonary oedema as a result of fluid accumulation. In cases of uremia this is precipitated as uremic pneumonitis (Cowgill and Elliot, 2000).

In the present study, it was found that most of the animals with severe renal disorders had ulcerative gastroenteritis, hypertrophy of the ventricles of the heart and pneumonia. As 40 per cent of the circulating gastrin is metabolised by the kidneys, reduced renal function leads to hypergastrinemia. Also, part of gastrin and histamine is normally removed by the liver and this function is impaired in cases with hepatic

damage. Thus, as stated by Polzin *et al.* (2000), elevated gastrin levels could have been the cause of gastropathy. Also, there is secretion of uric acid and other irritants through the gastrointestinal tract and lungs leading to ulcerations in the gastrointestinal tract and uremic pneumonitis. In cases where lesions were accompanied by dilatation of the heart, the lesions in the liver and kidney could have been due to damming back of blood in systemic and portal venous circulation resulting in impaired circulation and anoxia as pointed out by Sastry (1983a). Lesions in the heart could have also been a consequence of primary lesions in the liver or kidney.

Among the various types of histopathological lesions in the liver and kidney, vascular changes like congestion and haemorrhage were the predominant ones. In many cases, other internal organs also revealed congestion and haemorrhage, suggesting a systemic involvement. The probable causes could have been an acute infectious condition or toxin induced damage to vascular endothelium. The natural inquisitiveness of dogs often exposes them unnecessarily to toxic substances and the common sources include pesticides, paints, fertilisers, food preservatives, antiseptics and various fungal and bacterial toxins from

contaminated food materials. The liver and kidney play a central role in detoxification and excretion of many toxic substances and are therefore susceptible to toxic damage. A variety of chemicals, drugs and anaesthetics also damage the liver and as Rutgers (1996) pointed out, the actual cause is often never identified. Birnbaum *et al.* (1998) suggested that severe congestion and haemorrhage in the liver and kidney could be noted in acute leptospirosis as a result of vascular injury. In two cases where severe vascular changes were seen in the present study, leptospirosis was suspected considering the accompanying lesions like icterus, anaemia and haemoglobinuria apart from hepatosis and nephritis. Vascular lesions in the liver and kidney accompanied by pulmonary, epicardial and endocardial haemorrhages were seen in two cases where the history was suggestive of snake bite. Histologically, the epithelium of the cortical and medullary tubules of the kidney displayed an extensive acute necrosis with desquamation of tubular epithelial cells. Multiple hyaline casts were seen in the lumen of the tubules. The glomeruli revealed congestion of tuft and hypercellularity. Puig *et al.* (1995) reported similar lesions in a dog following *Vipera aspis* bite.

Degenerative changes like hydropic degeneration, fatty changes and necrosis were recorded in the liver and kidney in varying severities. Vacuolar degeneration was noted in 45 cases in the liver and 61 cases in the kidney, while necrosis was seen in 15 and 42 cases of the liver and kidney respectively. Kelly (1993) suggested that hydropic degeneration is a common change in hepatocytes in a number of diseases ranging from mild intoxication to hypoxia and that hepatocytes may be killed by toxic insult, activity of microorganisms, inflammatory reaction or by nutritional deficiencies and severe metabolic disturbances including hypoxia. Maxie (1993) suggested that many nephrotoxins produce vacuolar degeneration of the tubular epithelial cells of the kidney and that acute tubular necrosis could occur due to shock or ischemia. In many cases the liver and kidney revealed passive congestion, which could have been the cause of hypoxia and consequent necrosis. Also, an impairment in circulation as a result of damage to the glomeruli by toxins or microbes might lead to tubular necrosis.

In three cases where severe vacuolar changes were seen in the centrilobular areas of the liver and tubular epithelial cells of the kidney, there was history of treatment with corticosteroids. Similar

findings with corticosteroid therapy were reported by Rogers *et al.* (1977), Kelly (1993) and Rutgers (1996). Corticosteroids produce hypokalemia and reversible vacuolar degeneration of the tubular cells (Maxie, 1993). Hydropic degeneration in the parenchyma of the liver and kidney was noted in cases where the history revealed chronic vomition. Hypokalemia in such cases could have resulted due to loss of potassium ensuing vomition. A similar case has been reported by Maxie (1993).

In three cases where focal necrosis was found, *E. coli* was isolated from the liver. Strombeck and Guilford (1991) suggested that focal necrosis could occur in bacteremia, septicemia and other infectious conditions. In these three cases, as there was no isolation of organisms from the heart blood or kidney, an extension of infection from the gastrointestinal tract might have been the cause suggested.

In one case where centrilobular necrosis was seen, intranuclear inclusions were seen in the hepatocytes. It has been suggested by Kelly (1993) that viral infections such as canine adenovirus could produce periacinar necrosis. Hepatocellular swelling and sinusoidal damage reduce effective perfusion of periacinar hepatocytes. It is also possible that these

cells have greater intrinsic susceptibility to the viruses (Kelly, 1993). The presence of intranuclear inclusions in the glomerular epithelial cells also in this case, suggests an infection with canine adenovirus. Periportal necrosis was observed in five cases in the present study. Vegad and Katiyar (1998) suggested that periportal necrosis could occur when the hepatotoxin or the infectious agents enter the liver through the portal circulation or bile ducts.

Many antibiotics that are used routinely for treatment of infectious conditions are nephrotoxic. Bark and Perk (1995) have reported renal tubular necrosis in amoxycillin toxicity in a dog. Maxie (1993) stated that tetracyclins, aminoglycosides and sulfonamides produce necrosis of the tubular epithelial cells of the kidney. In many cases, the owners gave a history that the animal was treated with antibiotics before death. In such cases, its association with necrosis of renal tubular epithelial cells could be suspected.

Fatty changes were seen in 11 cases in the liver and eight cases in the kidney. Several pathogenic mechanisms such as increased hepatic lipogeneis, enhanced mobilisation of free fatty acids from adipose tissue, decreased hepatic oxidation of fatty acids,

impairment of triacyl glycerol secretory mechanisms or a combination of these factors are suggested (Linde - Sipman and Ingh, 1990). Fatty changes could have also been a result of hypoxia, deficiency of nutritional factors like choline, methionine or exposure to hepatotoxins. All these factors could have contributed leading to fatty changes in the present study. Strombeck and Guilford (1991) have proposed Diabetes mellitus as a frequent cause of hepatic lipidosis. In one case, in which urine sample was examined presence of sugar was detected. Renal lesions in this case revealed exudation in Bowman's space and hyalinisation of mesangial areas as evidenced by PAS Similar glomerular lesions were reported by Nakayama *et al.* (1986) in dogs with hyperglycemia and/or glucosuria. However, a definite conclusion that Diabetes mellitus could have been the cause of lipidosis in this case could not be arrived at, as the pancreatic lesions and blood glucose levels were not known.

Nineteen cases of liver revealed hepatitis of which, ten were periportal type. Strombeck and Guilford (1991) have suggested that periportal hepatitis accounts for 50 per cent of hepatitis in dogs and that it has no known cause. Bacterial products and other irritants absorbed from the intestine could have led to

irritation of portal areas resulting in mild fibrous tissue proliferation and infiltration in the area. Strombeck and Guilford (1991) found that the incidence of renal pathology with periportal hepatitis is twice as great in dogs as in the overall population. Membranous nephropathy was observed in one case of periportal hepatitis in the present study. This could possibly be due to the deposition of immunoglobulins as a result of interference in secretion of Ig^A into the biliary system in periportal hepatitis as suggested by Strombeck and Guilford (1991).

In a case of suppurative hepatitis where focal abscesses were seen in the liver, *Staphylococcus aureus* was isolated. Pyemic nephritis was also seen in this case and the same organisms were isolated from the kidney also. Johnson and Sherding (2000) reported that *Staphylococcus sp.* is a common pathogen in dogs. Since both liver and kidney showed pyemic foci and as organisms were isolated from both the organs, the route of infection can be assumed to be hematogenous. In two other cases of hepatitis, *E. coli* and *Enterobacter aerogenes* were isolated. Miller *et al.* (1996) have isolated *E. coli*, *Enterobacter aerogenes*, *Proteus vulgaris* and *Clostridium hemolyticum* from the liver of dogs with abcesses, while Johnson (2000) isolated

Staphylococcus sp., E. coli., Salmonella sp. and *Clostridium sp.* from hepatic abscess in dogs. Bunch (2000) isolated Staphylococcus and other gram negative organisms from the liver of dogs.

In many cases of hepatitis mild infiltration with mononuclear cells could be seen in the hepatic parenchyma in focal areas and they were not categorised into any separate group. The exact etiology in such cases was obscure. Toth and Derwelis (1980) reported hepatitis in a dog treated with trimethoprim and sulphadiazine. A possible hypersensitivity reaction was suggested by them, Rutgers (1996) proposed the role of immune mediated reactions in causing hepatitis, by diagnosing the presence of anti-liver membrane proteins in the serum of dogs with chronic hepatitis.

Hepatic cirrhosis was seen in two cases. In both these cases, ascites was noted. Decreased synthesis of plasma proteins by the damaged liver and the sodium retention as a result of decreased renal blood flow consequent to cirrhosis are the factors leading to ascites (Leib, 1997). Also as Sastry (1983a) reported, the inability of the damaged liver to inactivate the mineralocorticoids might have resulted in sodium retention and ascites. The serum ALT and ALP levels in this case were elevated. Sevelius (1995) has reported

normal to mild increase in the concentration of ALT and mild to moderate elevation of ALP levels in the serum of dogs with liver cirrhosis supporting the findings in this case. There was also marked hypoalbuminemia, which, as stated by Cornelius (1979) Dunn (1992) and Sevelius (1995) is a common feature in cirrhosis. Impairment in the protein synthesis as a result of hepatic damage can be attributed to hypoalbuminemia.

A case of hepatic cyst was seen in the liver. Smith *et al.* (1972) indicated that such cysts represent a malformation in which one or more primitive bile ducts lack an outlet or connection with the main biliary system. As observed by them, the cyst in the present study also was lined by cuboidal epithelium and the adjacent hepatic parenchyma suffered pressure atrophy and necrosis.

A case of cholangiocarcinoma was recorded in a dog. Histologically, fibrous tissue proliferation was marked and the tumour cells appeared undifferentiated, lacking the micro-acinar pattern. Fry and Rest (1993) and Wadhwa *et al.* (1996) reported cholangiocarcinomas in canines which were well differentiated with micro-acinar pattern and papillary projections. Reports regarding undifferentiated cholangiocarcinomas in canines are rare.

The present study revealed a high incidence of glomerular lesions in dogs. Rouse and Lewis (1975) also observed that GN is more common in dogs than previously recognised. Membranous nephropathy was identified in ten cases. Five of the cases of membranous nephropathy were associated with subacute or chronic interstitial nephritis. In one case it was seen associated with pyometra. Jaenke and Allen (1986) and Cheville (1989) also reported an association of membranous nephropathy with pyometra. In a case of hepatic cirrhosis also, MN was seen. This could have been due to impaired hepatic clearing of immunoglobulins as stated by Maxie (1993). Jaenke and Allen (1986) studied on MN in dogs and stated that the etiology is often obscure. They found that various systemic viral and parasitic infections, neoplasms and a number of drug and heavy metal toxicities are associated with MN. However, in majority of the cases, the antigen is not identified. Diffuse thickening of the capillary basement membranes of the glomerular tuft was noted in a case suspected for leptospirosis, which revealed subacute interstitial nephritis. Vegad and Katiyar (1998) observed deposition of anti-leptospiral antibodies in the capillary basement membranes. In another case where diffuse MN was seen, there was generalised icterus of the carcass with severe congestion of the liver, kidney and other

internal organs. Marked splenomegaly was noted. King (1999b) reported thickening of the glomerular basement membrane along with icterus and splenomegaly in a dog with autoimmune hemolytic anemia following incompatible blood transfusion.

Proliferative glomerulo nephritis was recorded in 18 cases. Out of this, two animals also had acute interstitial nephritis, two animals had pyemic nephritis and one animal showed pyometra while, none of the cases of PGN were associated with subacute or chronic interstitial nephritis indicating an association of PGN with neutrophilic reactions and the subsequent release of chemical mediators. Basophilic intranuclear inclusions were seen in the glomerular epithelium of one animal showing PGN. Jaenke and Allen (1986) have reported the occurrence of PGN with canine adenovirus infection. In most of the other cases, no specific etiology could be identified.

Urine samples examined in cases with glomerular lesions revealed marked proteinuria. Polzin *et al.*(2000) stated that proteinuria is a hallmark of glomerular injury and dysfunction. Disturbances in intraglomerular hemodynamics can induce proteinuria. Koeman (1987) suggested that proteinuria in glomerular lesions can be based on defects in pore size and charge

variations in the basement membrane due to deposition of immune complexes.

Tubulo-interstitial nephritis was recorded in 16 cases. In three cases of sub acute interstitial nephritis, lesions were suggestive of leptospirosis. Grossly, there was generalised icterus and hemoglobinuria with congestion of the liver, kidney and other internal organs. Epicardial and endocardial haemorrhages were seen. Kidney sections of these animals revealed moderate to severe lymphoplasmacytic tubulo-interstitial nephritis. In two of these dogs, liver sections revealed marked central venous and sinusoidal congestion with mild periportal inflammation. In the third case, extensive vacuolar degeneration of hepatocytes was noted. Similar lesions were reported in leptospirosis by Birnbaum *et al.* (1998). However, organisms could not be demonstrated by Warthin-stary or Levaditis staining techniques. In a study conducted by Birnbaum *et al.* (1998) in 28 dogs with leptospirosis, organisms were demonstrated in the renal tubules in only one case. They stated that it is difficult to visualise the organisms in sections in subacute or chronic stages of infections and after antibiotic treatment. In the present study also, all

the three dogs had history of prior treatment with antibiotics.

In two cases of pyelonephritis, pyometra was seen concurrently. Ascending infections from the genital tract could have been the cause of pyelonephritis. *E. coli* and *Pseudomonas aeuruginosa* were isolated from each case respectively. Similar organisms were reported to cause pyelonephritis (Smith *et al.*, 1972).

In a case of pyemic nephritis, *Staphylococcus aureus* was isolated from the kidney. Suppurative hepatitis was seen in the same case and the same organisms were isolated from the liver suggesting a systemic bacterial infection. In three out of six cases of chronic interstitial nephritis where serum biochemical and haematological values were obtained from the Veterinary clinic, the BUN and creatinine levels were significantly increased. All these three animals had severe gastro-intestinal ulcerations and pulmonary haemorrhages suggesting a state of uremia. Elevation in BUN and creatinine levels was reported by Mc Caw *et al.*(1989) and Srinivasan *et al.* (1993) in dogs with chronic renal failure. In these three cases, there was significant reduction in haemoglobin and erythrocyte counts indicating the presence of anemia. Polzin *et al.* (2000) stated that erythropoietin

deficiency is the major cause of anaemia in renal disorders. The values of potassium in the three dogs with chronic interstitial nephritis was significantly elevated as reported by Polzin *et al.* (2000). In the other cases of chronic interstitial nephritis also, though the values were not available, a similar serum biochemical and haematological picture can be expected as the gross and histopathological lesions were similar.

In many cases, the lesions in the glomeruli co-existed with tubulo-interstitial lesions. In such cases, the initial or the primary part affected could not be identified. Polzin *et al* (2000) stated that the inability to identify the inciting cause of renal failure is because of the functionally interdependant nature of various components of the nephrons. Also, lesions in the glomeruli decrease the capillary perfusion of tubules and thus induce progressive tubular degeneration.

Bacterial isolations were obtained from 11 out of 40 cases (28 per cent) with inflammatory lesions in either liver or kidney or both. Bacterial agents were also associated with three cases of hepatic necrosis, but, in majority of the animals which showed only vascular and degenerative changes, no association with

bacterial pathogens could be made. This indicated that most cases of inflammatory conditions were associated with some infectious cause, while vascular and degenerative changes could be associated with some toxic factors.

Due to their inquisitive nature, dogs have higher chances of getting exposed to many toxic agents but, the etiology is often unidentified. So, it is imperative that further studies be conducted in these lines to identify the possible etiology in such cases. Also, a higher incidence of glomerular and tubulo-interstitial lesions in canines indicate further studies in these lines.

The study has helped in correlating the clinical signs of dogs with hepatic and renal disorders, and also in the classification of different types of histopathological lesions. The investigation proved beyond doubt that hepatic and renal pathology in canines are more common than expected. This will create an awareness among clinicians on the common disorders affecting these organs and aid them in choosing suitable preventive and curative measures.

SUMMARY

6. SUMMARY

An investigation was undertaken to study the prevalence and pathology of hepatic and renal disorders in canines.

Data regarding the incidence of hepatic and renal disorders in canines for a period of five years (March1995-February 2000) were collected from the records maintained at the Centre of Excellence in Pathology, College of Veterinary and Animal Sciences, Mannuthy and lesions were analysed. Besides this, one hundred samples of the liver and kidney obtained from the carcasses of dogs autopsied between March 2000 and August 2001 at the Centre of Excellence in Pathology, Mannuthy were subjected to a detailed systematic, gross and histopathological examination. Samples for bacteriological studies were collected from the liver, kidney and heart blood in appropriate cases. Urine samples were collected in all available cases. The history and other details regarding the animals were obtained from the owners and documented in the proforma prepared.

It was found from the past records that 86 per cent had gross lesions either in the liver or kidney or both. 75 per cent of cases had lesions in the liver and

82 per cent had lesions in the kidney. In the present study also, pathological changes were observed in 76 and 85 per cent of cases in the liver and kidney respectively.

Among the liver disorders, it was found that animals more than five years of age and animals between 1-3 years of age were more affected, while there was no significant difference in the incidence of renal lesions with respect to age. There was no difference between the sexes with respect to the liver lesions, but percentage of incidence of renal disorders was higher in females. German Shepherds had a higher percentage of incidence of the liver and kidney disorders followed by non-descripts.

In many cases with hepatic and renal disorders, the clinical signs reported were anorexia, vomition, neurological signs and respiratory distress. The gross lesions in other organs included gastro-enteritis, pulmonary congestion and haemorrhage, pneumonia and dilatation of heart.

Vascular lesions were predominant among the various histopathological lesions encountered in the liver and kidney. Varying degree of congestion and haemorrhage were noted in 58 and 37 cases of the liver

and 62 and 30 cases of kidneys respectively. The involvement of an acute infectious condition or a toxin was suspected in most of these cases. Hydropic degeneration and fatty changes were seen in 45 and 11 cases of the liver and 61 and eight cases of kidneys respectively. The possible causes suggested were hypoxia, involvement of toxin or administration of certain drugs like corticosteroids.

Necrosis was documented in 15 cases of the liver and 42 cases of kidneys. In three cases where focal necrosis was seen in the liver, *E. coli* was isolated. Four types of necrosis were seen in the liver viz. focal, periportal, centrilobular and diffuse.

Hepatitis was recorded in 19 cases. It was classified as focal, periportal and suppurative. In three cases of hepatitis, bacterial isolation was obtained which included one each of *E.coli, Enterobacter aerogenes* and *Staphylococcus aureus.* These three cases revealed inflammatory reaction in the kidney also. Fibrosis of the liver was seen in nine cases and cirrhosis in two cases. Hypoalbuminemia and elevated serum ALT and ALP levels were recorded in one case of cirrhosis.

A total of 59 cases had lesions in the glomeruli. Glomerular nephritis was seen in 32 cases. Out of these, 10 had membranous nephropathy, 18 had proliferative GN and four had membrano-proliferative GN. Proliferative GN was common in animals less than three years while membranous and membrano-proliferative GN were common in middle aged and older animals. Males had a higher tendency for PGN while there was no sex difference with respect to incidence of membranous nephropathy. Non-descripts had a higher percentage of incidence for all the three types. Urine samples examined in most of the cases with glomerular lesions revealed marked proteinuria.

Sixteen cases revealed tubulo-interstitial nephritis, which were grouped into three categories as pyelonephritis (2), interstitial nephritis (12) and pyemic nephritis (2). Two cases of acute interstitial nephritis were seen in animals less than five years of age, while all cases of chronic interstitial nephritis was recorded in animals more than five years of age. There was an increased tendency for interstitial nephritis in males while both the cases of pyelonephritis were seen in the females. *E. coli* and *Pseudomonas aerugenosa* were isolated from each case of pyelonephritis respectively.

In three cases of subacute interstitial nephritis, leptospirosis was suspected, considering the accompanying lesions like icterus, haemoglobinuria and hepatosis. However, the organisms could not be demonstrated in the sections of the liver or kidney.

In three cases of chronic interstitial nephritis, there was significant reduction in haemoglobin and total erythrocyte counts and an increase in BUN, creatinine and serum potassium levels. *Enterobacter aerogenes* was isolated from a case of acute interstitial nephritis. In seven cases of subacute and chronic interstitial nephritis, bacterial isolation was obtained which included four *S. aureus*, two *E. coli* and one *Proteus sp.*

One case each of cholangiocarcinoma, hepatic cyst, adhesion of diaphragm and liver, hydronephrosis and renal abscess was encountered during the course of this study. Basophilic intranuclear inclusions were seen in the hepatocytes in two cases. In one case, similar inclusions were seen in the glomerular epithelium also.

The systematic investigation undertaken has proved that disorders of the liver and kidney are more common than expected. The higher incidence of glomerular lesions in the dogs indicated the need for further

studies in these lines. Also, toxic conditions are very common in the dogs and the etiology in most cases is unidentified. Therefore, a detailed investigation can bring to light the etiology in such cases. The result of this study will create an awareness among clinicians about the common disorders affecting the liver and kidney of the dogs, which will aid them in choosing suitable preventive and curative measures.

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APPENDIX I

SL. NO DATE:

AGE SEX BREED:

BODY WEIGHT:

WEIGHT OF THE LIVER:

WEIGHT OF THE KIDNEY:

HISTORY

CLINICAL SIGNS BEFORE DEATH:

GROSS EXAMINATIONS AT NECROPSY:

1) LIVER

2) KIDNEY

3) OTHER ORGANS

URINE ANALYSIS:

BACTERIOLGICAL STUDIES:

TOXICOLOGICAL STUDIES:

REMARKS:

APPENDIX II

HISTOPATHOLOGICAL EXAMINATION

A. LIVER

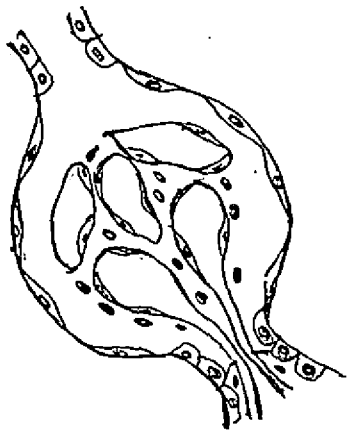
1. Vascular changes:
   - Congestion
   - Haemorrhage
   - Oedema
2. Degenerative changes
   - Vacuolar degeneration
   - Fatty change
   - Pigment accumulation
   - Necrosis
3. Inflammatory changes
   - Hepatitis
4. Proliferative changes:
   - Fibrosis
   - Cirrhosis
   - Bile duct proliferation
5. Neoplastic changes
6. Other changes
   - Cyst
   - Adhesion of diaphragm and liver
   - Inclusion bodies

B. KIDNEY

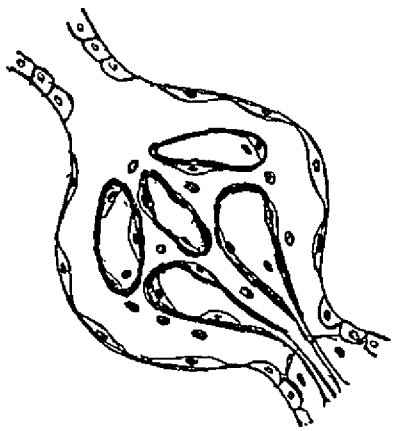
1. Vascular changes
   - Congestion
   - Haemorrhage
   - Oedema
   - Infarction
2. Glomerular changes
   - Membranous nephropathy
   - Proliferative glomerulo nephritis
   - Membranoproliferative glomerulo nephritis
   - Other glomerular changes
     - fragmentation of tuft
     - atrophy of tuft
     - adhesion of parietal and visceral layers
     - exudation in Bowman's space
     - thickening of parietal layer
3. Tubular disorders
   - Vacuolar changes
   - Fatty changes
   - Pigment accumulation
   - Necrosis
4. Tubulointerstitial disorders
   - Pyelonephritis
   - Interstitial nephritis
   - Pyemic nephritis
   - Abscess
5. Others
   - Hydronephrosis

APPENDIX III

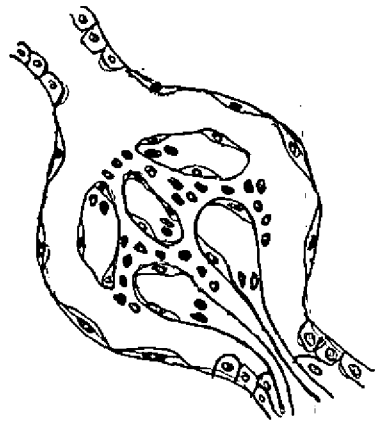
BASIS FOR CLASSIFICATION OF GLOMERULO NEPHRITIS



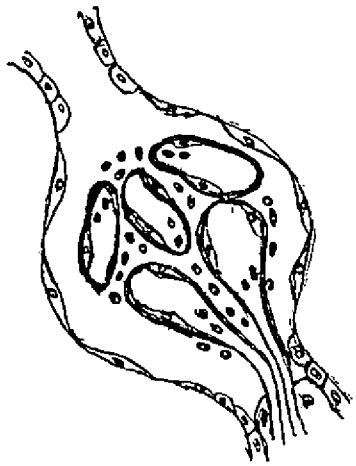
NORMAL GLOMERULUS



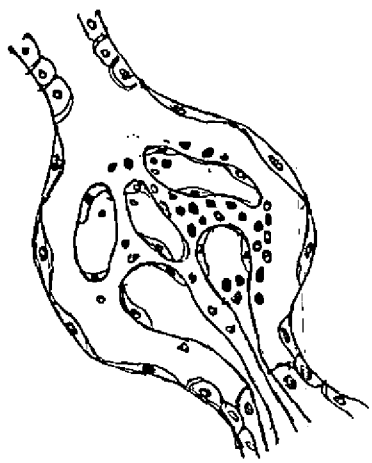
MEMBRANOUS
NEPHROPATHY



PROLIFERATIVE
GLOMERULO NEPHRITIS



MEMBRANO PROLIFERATIVE
GLOMERULO NEPHRITIS



SEGMENTAL
GLOMERULO NEPHRITIS

HEPATO - RENAL PATHOLOGY IN CANINES

By
R. LAKSHMI.

ABSTRACT OF A THESIS

Submitted in partial fulfilment of the requirement for the degree of

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

Centre of Excellence in Pathology
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
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2001

ABSTRACT

The present investigation was undertaken to assess the prevalence and pathology of the liver and kidney disorders in canines. The results of the present investigation and the evaluation of data from the records revealed a high incidence of liver (76 per cent) and kidney (85 per cent) disorders. A detailed systematic examination of one hundred cases of canine carcasses brought for autopsy during the period of investigation was conducted and the gross and histopathological lesions were studied in detail and were classified based on age, sex and breed.

Vascular and degenerative changes were the predominant lesions in these organs. The other lesions recorded in the liver were necrosis (15 cases), hepatitis (19 cases), fibrosis (9 cases) and cirrhosis (2 cases). One case each of cholangiocarcinoma, hepatic cyst and adhesion of diaphragm and the liver was encountered in the present study. Among kidney disorders, glomerular lesions were predominant next to vascular and degenerative changes. A total of 59 cases had some lesions in the glomeruli of which, 32 had glomerulonephritis. PGN was the predominant type of glomerulonephritis. Males had a higher predilection for

PGN and it was common in animals less than three years of age. MN and MPGN were common in animals more than three years of age. The high incidence of glomerular lesions and their possible causes were discussed. Tubulo-interstitial nephritis was observed in 16 cases. Interstitial nephritis was common in males while both cases of pyelonephritis were seen in females. Acute interstitial nephritis was seen in animals less than five years of age while all cases of chronic interstitial nephritis was seen in animals more than five years of age.

Bacterial isolations were obtained in the liver or kidney or both in only 14 cases. Viral etiology was suspected in two cases where intranuclear inclusions were seen in the hepatocytes and the glomerular epithelium. The high incidence of vascular lesions without any evidence for infectious etiology in rest of the animals suggested the involvement of some toxic factors. The importance of identifying the specific etiology in these suspected cases of toxic conditions and the need and scope for further studies in these lines were highlighted.