OBSERVATIONS ON RENAL PATHOLOGY IN SWINE

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INTRODUCTION.

The kidney is a vital organ which while performing its excretory functions is also responsible to a great extent in maintaining the internal environment of the body to meet the ever fluctuating body requirements. However, the fact that over a fifth of the total blood of the body circulates through the kidneys every minute, exposes them widely to injury, should poisons or toxins be present in the blood and the resulting altered function is reflected in a disturbance of functions of other organ systems. As pointed by Robins 1960 (51) the diseases of the kidney make up major segment of the total burden of disease. Diseases primary in this organ is the basic cause of approximately 10% of all deaths. More often from the standpoint of morbidity, renal disease is the tenth most important cause of illness.

The frequency, varieties and pathology of renal disease in most of the domestic animals are well known to the Veterinarians but similar information in respect of pig is not available to the same extent. At present pig husbandry is assuming importance in India as it promises to supplement the much needed protein at comparatively cheap price. It is felt that in this context, the understanding of renal pathology in pigs is of considerable importance for an integral animal husbandry. With this view in mind the present study was undertaken to assess the types and frequency of porcine renal diseases.
II AIMS AND OBJECTS

The present study is aimed at observing the incidence and study of histological alterations in the kidney of the pig under the following heads:

I. Congenital defects.
II. Concretions.
III. Parasitic diseases.
IV. Other systemic diseases

and

V. Inflammatory diseases.

III MATERIAL AND METHODS

The material for the study was collected from 500 pigs slaughtered at the Bombay Municipal Corporation slaughter house for pigs. Usually the pigs are imported from Dhulia, Nasik, Bhuseval, Barad and Bijapur of Maharashtra State. The collection was made during a period spreading over four months.

After slaughter and dressing of the carcasses they were subjected to post mortem inspection. At this time the kidneys could be examined grossly in situ, although occasionally in few animals a kidney might get detached while dressing the carcass.

60 organs which showed lesions on gross examination, were selected for further histological study.

The organs selected were measured, weighed and were sectioned.
sectioned along their long axis. The cortex and medulla were
grossly examined and their respective thickness was measured.
Pieces of suitable thickness were fixed in 10% buffered forma-
saline and were embedded in paraffin after usual processing. For
comparison some normal kidneys were collected and subjected to
the same procedure.

Some organs showing obvious gross lesions were utilized
for mounting as museus specimens.

The paraffin sections were cut at six microns thickness
and stained with Haematoxylin-Eosine (35) for routine histological
study. However the following special staining methods were also
employed in respect of some tissues when found necessary.

1) Levaditi's (35)
2) Periodic Acid Schiff (35)
3) Grae's (35)
4) Gomori's iron reaction (35)
5) Crystal violet (35)
6) Masson Trichrome (35)

All the sections were mounted in canada-balsam.

No information was available regarding the age of the
animals and nature of the etiological factors responsible for
the renal damage.
An extensive search of literature on renal diseases revealed that while a considerable amount of information is available pertaining to most of the domestic animals, it is very scanty as far as pigs are concerned. Unavoidably, therefore, the review of pathological conditions in animals other than pigs forms the basis of the present study.

Congenital abnormalities such as aplasia of one kidney, polycystic kidney, horse shoe kidney &c. are reported from most of the domestic animals. Groth 1955 (25) encountered polycystic kidney in three piglets which were related through their dam. This relationship led him to believe that polycystic kidney is an inherited character. Bloom 1954 (11) observed that foetal lobulation is a commonly encountered condition in pigs but uncommon in dogs and cats.

Urolothiasis is an acquired pathological condition, the incidence of which according to Fleming is more in horses than other domesticated animals. This is confirmed by Hutynia et al 1960 (30) who gave the following incidence in different animals, horses 0.5%, dogs 0.3% and cats 0.2%. Newson 1935 (45) recorded 36 cases of urinary calculi in canines out of which 28 were of phosphate, eight were of phosphate and oxalate, two were of cystine and one of uric acid. White 1944 (66) recorded 66 cases of cystic calculi, 31 cases of urethral calculi and one of renal.
Bloom 1954 (11) stated that nephrolithiasis is uncommon in dogs except in Dalmatians and is rare in cats. Williams et al 1955 (65) recorded a case in pig with prolapse of rectum due to calculi in the bladder.

Osborn et al 1917 (48) reported a high incidence of calculi in their vitamin 'A' deficient rats. However, the role played by vitamin 'A' in the causation of lithiasis is subject to controversial views. Bannan and Young 1926 (4) stated that normal urine contains twice as much organic as inorganic matter and the imbalance of this ratio may cause lithiasis. According to Blount 1931 (12) in the Dalmatian the high acidity of urine which is a Mendelian dominant character, is responsible for the greater frequency of calculi formation in that breed. The same author has given silicates and calcium oxalate in acid urine and triple phosphate and calcium carbonate in alkaline urine, as the chief constituents of urinary stones in pigs. He considers that the reaction of the urine is a potential cause of calculus formation and other factors such as presence of a nucleus, excess of food, rich in salt and organic compounds and metabolic disturbances are also equally important. Newson 1938 (45) while supporting this view also incriminates hard-water, vitamin 'A' deficiency and infection. Albright et al 1934 (1) reported that in ten out of 17 cases of hyperthyroidism presence of urinary calculi was observed. Matsuoka 1952 (64) stated that the colloids in the urine coat the microscopic crystals and prevent them from forming aggregations. According to him, strong peptizing agents such as hyaluronidase have been demonstrated to have some
some value in controlling urolithiasis.

In pigs, kidneys are not infrequently invaded by parasites and Stephanurus dentatus is a commonly encountered nematode. It was originally discovered by Natterer 1834 (44) and later described by Riesing 1839 (23), White 1858 (66), Morris 1971 (41), Tayler 1900 (61) and Soundney 1983 (21). According to Bernard et al 1914 (7), the infection may take place either through unbroken skin or by mouth but Schwarts et al 1928 (55) rejects the theory of infection through unbroken skin. Spindler 1934 (58) in a survey, recorded an incidence of 51% of these worms in the kidney. According to Thornton 1957 (62) 11% of slaughtered pigs are condemned as unfit for human consumption in Australia owing to the affection of kidney due to this worm. As reported by Price 1927 (59), this parasite is some times associated with posterior paralysis due to its presence in the spinal canal.

Another parasite not uncommonly observed in the kidneys is the cystic stage of Schiniscoccus granulosus, the tapeworm of the dog. According to Nagath 1957 (38) in the swine one animal in 2400 animals is affected with hydatid disease and he believes that the incidence of hydatid disease in hogs is increasing.

In the discussion at WHO/FAO seminar on meat hygiene at Copenhagen in 1954 (67) it was remarked that "Hydatidosis has shown an increase in many countries". Thornton 1957 (62) quoted German authorities for the incidence in pigs as 2% in kidneys. The simple unicellular cyst is the commonest form encountered in pigs, and
and according to Lapage 1959 (33) 20% of these are sterile.

A progressive accumulation of urine in the kidney destroys the parenchyma so that in extreme cases all that remains is a sac containing urine - a condition called as Hydronephrosis. Hutrya et al 1949 (30) and several other authors have frequently observed this condition in cattle, pig and sheep. Lucas (36) found this condition in 0.67% of 6425 pigs and Brown (29) in 0.31% of 1700 sheep. Leighton 1905 (34) recorded a case of canine hydronephrosis associated with congenital absence of the other kidney. Damodaran 1950 (20) recorded five cases of canine hydronephrosis and opines that in the pig the confirmation of the urinary organs predisposed to hydronephrosis. This is corroborated by Bloom 1954 (11).

Kidneys are subject to inflammatory process both of specific and non-specific variety. Hutrya et al 1949 (30) divided the renal inflammatory process into acute and sub-acute types. He subdivided the acute form into the parenchymatous and diffuse types and the chronic form into the diffuse glomerulo nephritis and interstitial forms. Muller et al 1936 (42) though agreeing with the primary classification into the acute and chronic types, gives parenchymatous and interstitial subtypes of the latter, making no attempt to sub-classify the acute type. Bramly 1931 (17) accepted the sub-classification of chronic type but divided the acute form into three groups viz. parenchymatous, haemorrhagic parenchymatous and diffuse. Bloom 1959 (9) on the other hand classifies the process into three distinct categories
categories viz. degenerative (nephrosis), inflammatory (nephritis) and vascular (arterio-sclerotic). He subdivided inflammatory nephropathies into supplicative and interstitial nephritis but he did not classify glomerulo nephritis and arterio-sclerotic kidney. The simplest of these classifications given by Gaiger and Davis 1936 (26) is that into supplicative and non-suppurative with subtypes according to the part more prominently involved or the mode of origin and the same is adopted here.

Glomerulo nephritis according to Hanchean 1935 (37) is the most important form of nephritis in the horse, he recognises a disseminated type of glomerular nephritis which includes cases of embolic nephritis in equines but most authors have treated this as a class apart. The same author and Bloom 1937 (8) however opine that in dogs primary glomerular nephritis is rare and of little significance. McFadyean 1939 (39) was of the opinion that glomerulo nephritis both of acute and chronic variety is rare among the domesticated animals. He had however encountered kidneys in which considerable number of the Malpighian bodies contained crescents and classed this as catarrhal glomerulo nephritis. According to Smith et al 1960 (57) the pathogenesis of glomerulo nephritis is obscure and appears to depend upon toxic substances developed in the course of antigen antibody reaction.

Bell et al 1931 (6) produced a form of chronic diffuse glomerulo nephritis in a monkey by repeated intravenous injections of streptococci over a period of four years.
Though the term nephrosis was originally applied to degenerative or retrogressive changes within the tubular epithelium, all conditions primarily affecting tubules were later included in this. Jacob 1924 (31) believed that epithelial or tubular nephrosis and nephrosclerosis occurs most frequently in animals. McFadyean 1929 (39) called this as catarhal tubular or parenchymatous nephritis. Rabin 1960 (61) divided this condition into chemical, toxic, vascular, lower nephron, glycogen and thrombotic nephrosis depending upon the cause. Bloom 1954 (11) considers that amyloid nephrosis is the only type of chronic nephrosis affecting the kidney of animals. Burwell 1955 (18) produced necrosis and disquamation of the cells in proximal convoluted tubules by temporary complete renal ischaemia. Moore 1967 (40) produced necrosis of proximal tubules in rats by inducing cholinedeficiency and suggested on histological grounds that vasospasm may be the operative agent.

McNider 1916 (37), Bloom 1937 (8), 1939 (9) and Platt 1951 (49) consider that interstitial nephritis is the commonest and most important non-suppurative inflammatory disease of the kidney in the domesticated animals. Davis 1906 (23) and Bloom 1937 (8) recognised an acute type of the disease characterised by a cellular infiltration of mononuclear and lymphocytes in the interstitial tissue. Henchon 1923 (27) considers these cells to be intermediary between the lymphocytes and polyblasts while Nieberle et al 1931 (46) believe that they are histiocytes. McFadyean 1929 (39) stated that cases of chronic interstitial nephritis
nephritis having resemblance to either primary granular contracted kidney of the human are extremely rare in the domesticated animals with the exception of carnivora.

Anon 1948 (2) stated that chronic nephritis is frequent in dogs and 47.4% showed chronic renal affections, out of 3374 dogs observed by the Munich faculty. Bloom 1954 (11) indicated that some degree of interstitial nephritis occurs in approximately 55% of dogs and 3% of cats in routine autopsies.

One of the earliest records of suppurative nephritis in animals is that by Brucknuler 1869 (16) who observed abscesses in the kidney of an ox. Lamann 1877 (19) described a case of bacillary nephritis in which the convoluted tubules were filled with organisms. Guillebeau et al 1892 (26) gave a complete account of the different clinical symptoms, microscopic lesions and the pathogenic organisms affected with the disease. McFadyean 1929 (39) considers that all cases of embolic nephritis are secondary and he stated that glomeruli form the starting point of abscess of the great majority but some begin in the capillaries of the intertubular plexuses. McFadyean thinks that contrary to what appears to be generally the case in embolic nephritis, the infection does not operate simultaneously in all the tubules although all are exposed to the risk as soon as the bacteria have reached the renal pelvis. Sastry 1951 (54) produced pyelonephritis and abscesses by injecting organisms into the renal artery in dogs. In this the interstitial tissues were infiltrated with cells which were predominantly mononuclears in the E.Coli and and proteus
proteus infection and polymorphs in pseudomonas aeruginosa infec-
tion and there was fibrosis, atrophy and disappearance of glomeruli.
According to Bollinger 1891 (13) next to tuberculosis and hepatic
distematosis, pyelonephritis was the third most common disease of
cattle.

Jowett 1928 (32) isolated corynebacterium pyogenes from a
bovine kidney. McFadyean 1939 (39) and Boyd 1937 (15) consider
that staphylococci, streptococci, B. coli and corynebacterium
renale are the common causative organisms. Weidlich 1954 (63)
recorded C. renale as the causative organism of pyelonephritis
in pigs.

V OBSERVATIONS AND DISCUSSIONS

(a) CONGENITAL DEFECTS.

(1) Foetal Lobulation:-

In the present study only one animal showed unilateral
lobulation in left kidney (No. 98). Though the kidney had deep
grooves on one side, it was found to be normal microscopically.
These grooves might be due to persistence of foetal lobulation.
This is a common anomaly in man but rare in animals and according
to Bloom 1954 (11) is occasionally observed in swine.

(2) Abnormal Shape:-

In one animal the left kidney (No. 98) was found to be
abnormal in shape. It was long and narrow with one end very much
pointed and the other rounded. The lateral border was concave
and the medial convex (Plate I). The kidney measured 11x3x7 cm.
in length, breadth and circumference respectively and weighed 100 gms. In the present case the length was more and breadth less than normal.

(3) Polycystic Kidney:

The right kidney (No.89) was cystic and was lobulated though normal in size and weight. The cut surface had a honey comb appearance and showed numerous cysts varying in size from a few mm. to 10 mm. separated by only a thin fibrous septum (Plate II) and containing straw coloured fluid. The cysts were not communicating with the pelvis. There was a compensatory hypertrophy of the left kidney which was twice the normal size (Plate III).

Microscopically the cysts were seen in both the cortex and medulla. Renal parenchyma was much reduced in amount. Many of the glomeruli were hyalinised, fibrosed or completely atrophied. Fibrosis and thickening of the Bowman's capsule was present. There was extensive replacement fibrosis in the cortex. Many of the tubules were atrophied, others were dilated. The pelvis was lined by transitional epithelium and by a mass of connective tissue in which a few large medullary ducts were still discernible indicating that the medullary tissue was almost completely atrophied. The left kidney showed lesions characteristic of chronic interstitial nephritis.

Bloom 1954 (11) attributes this condition to persistence and enlargement, instead of involution of the normally formed cysts.
cysts of the first several generations of convoluted tubules that become separated from the collecting tubules in the foetus.

(b) CONCRETIONS.

In the present study only one animal showed bilateral renal calculi, an incidence of 0.3%. Williams et al 1985 (69) recorded a case of vesical calculi in pig. Grossly the left kidney (No.100) had a smooth surface and on section gritty, sand-like material observed at one pole at the junction of cortex and medulla and the pelvis was slightly dilated. The right kidney (No.101) showed a hard mass at one pole on which the capsule was adherent. On section a calculus 1.8x1.0 cm. (Plate IV) which had a rough granular surface was seen in the cortex. Microscopically the renal tissue was normal except for slight fibrosis in the cortex and medulla.

(c) PARASITES OF KIDNEY.

(1) Stephanurus dentatus:-

Two animals showed perirenal parasitic cysts, the infection being bilateral in one. The incidence works out to be 0.4% is much smaller than recorded by Spindler 1955 (59) - 51.3 and by Thornton 1957 (62) - 11.5.

The cyst in the left kidney (No.122) measured 3x1 cm. and contained three parasites and that of the right kidney (No.123) measured 6x3 cm. and contained with many worms. On opening this kidney a parasite was found in the pelvis. The third kidney (No.124) had a small cyst attached to the ureter and contained a single parasite. In all these cases the ureter was found to be very
very much thickened and tortuous.

Microscopically only kidney No. 134 showed a healed infarct, while other kidneys were normal. Similar infarcts were also observed by Ross et al. 1932 (52). In all cases the wall of the ureter was thickened and fibrosed. While some of its epithelial cells showed hydropic degeneration, in one section endarteritis obliterans was also observed. The wall of the cyst was fibrosed and infiltrated with round cells and fibroblasts. Sections of the parasite with uterus and eggs was seen in cystic cavity. The parasite was identified as Stephanurus dentatus.

The presence of parasite in the kidney proper as seen in specimen No. 133 was also recorded by Spindler 1956 (69). According to whom the worm reaches the pelvis by penetrating the ureter and crawling up through it. The significance of this condition lies in the fact that it amounts to heavy economic loss. According to Seddon 1950 (56) the removal of the affected kidneys caused rejection of 50% carcasses for export from Australia.

3) Hydatid Disease:

Five animals showed unilateral hydatid disease of kidneys (Nos. 49, 88, 94, 115 and 139) the incidence amounting to one percent. Thornton 1957 (62), Magath 1957 (36) and Nashville 1936 (43) quoted the incidence in pigs as 2%, one in 2400 and 0.64% respectively.

Grossly all kidneys showed one to four cysts. Two organs (Nos. 49 and 115) showed single large cysts measuring 4x8 cm. (Plate V). All cysts were sterile, unilocular and contained straw
straw coloured fluid.

Microscopically the cyst wall consisted of a concentrically laminated cuticular membrane, (Plate VI) surrounded by fibrous tissue infiltrated with inflammatory cells and foreign body giant cells (Plate VII). In the adjacent area, glomeruli and tubules showed degenerative changes due to pressure atrophy. Besides the cyst, one organ (No. 94) also showed acute diffuse nephritis.

Similar microscopic picture was given for the hydatid cyst by Thornton 1957 (62) and Sundaram 1960 (60). According to Lapage 1959 (33) about 20% of the hydatid cysts in pigs are sterile however in the present study all of them were found sterile. The hydatid disease is very important to swine breeder as it causes economic loss due to condemnation of the affected kidneys.

(d) OTHER SYSTEMIC DISEASES.

(1) Hydronephrosis:

Three animals showed unilateral hydronephrotic kidneys (Nos. 10, 11 and 117), the incidence being 0.6% which is comparable with Lucke's (36) observation of 0.67% incidence in 6485 pigs. Grossly all the three organs were enlarged and bulging and on section exhibited distension of pelvis with clear colourless fluid. In one organ (No. 117) the bulging was more prominent and the cortex was measuring 0.4 cm. The medulla also was completely atrophied. The cavity in the pelvis measured 4x4 cm. and showed ridges. In all these cases the remaining kidneys were found to be normal.

On microscopic examination the medullary tissue was found to be
to be completely atrophied and the pelvis was directly in apposi-
tion to the cortical tissue. The wall of the pelvis was fibrosed
and thickened. Many of the glomeruli showed fibrosis and hyali-
nisation and the tubules showed pressure atrophy (Plate VIII).

Bawdonron 1960 (30) has stated that the confirmation of
the urinary organs predisposed the pig to hydronephrosis. Since
1954 (11) stated that first changes are seen in the tubules which
later show solid cords with small lumen. The glomeruli in which
the changes are slow to show up, become fibrous and hyalinised.
In the present study the damage was not so extensive and distruc-
tion was limited except in organ No.117. Smith et al 1960 (57)
considered the arrest of blood flow due to pressure was more
important for the destructive process. According to Anthony
1958 (3) many cases of so called hydatid cysts in pigs are hydro-
nephrotic rather than cystic.

(b) Infarcts and Scars:

Of the 500 animals four showed kidneys (Nos.119, 110, 118
and 124) with scars unilaterally. The scars were depressed,
irregular and on one side only (Plate IX). The capsule was
adherent firmly at these places. In later three cases, the
other kidney was found to be normal. In No.119 the kidney was
atrophied, oval in shape, measured 4.4x6.5 cm. and weighed only
30 gms. The right kidney of this animal was very much hyper-
trophied and weighed 220 gms. In No.124, the kidney was infected
with Stephanurus dentatus.

Microscopically the capsule was thickened and the fibrous
tissue
tissue extended deep into the cortex and the few remaining glomeruli present in this region showed syrinxation. In one, (No. 119), there was cystic dilatation of the tubules and few inflammatory cells were present in the surrounding area. The enlarged kidney showed histology of chronic nephritis.

According to Bloom 1954 (11) scar formation represents healed infarcts. It is very difficult to differentiate grossly healed infarcts from scars of chronic interstitial nephritis, but in the present study none of the organs showed changes of chronic nephritis microscopically. According to Boyd 1962 (14) kidneys are one of the commonest sites of infarcts because of enormous circulation and the "end-organ" type of circulation. Extensive scar formation on one side leading to marked atrophy of one kidney (No. 119) was seen and this might have been due to occlusion of one of the main branches of the renal artery. The compensatory hypertrophy of the other kidney in this case was quite appreciable even though it was showing chronic nephritis as the size and weight was more than twice the normal kidney. Bloom 1954 (11) states that infarcts are common in swine.

(3) INFLAMMATORY DISEASES.

(1) Glomerulo nephritis (acute and sub-acute):

Of the 500 animals examined six had glomerulo nephritis, only one having bilateral (Nos. 107 and 108) acute glomerulo nephritis. One animal showed acute inflammation in one kidney (No. 89k) and sub-acute in the other. The incidence of glomerulo nephritis was 1.76 that of acute glomerulo nephritis being 8.84
one of sub-acute glomerulo nephritis being 6.6.4. only two kid-
neys (Nos. 6k and 9) were showing sub-acute glomerulo nephritis
and the remaining six showed acute glomerulo nephritis. Crossly
seven kidneys (Nos. 6k, 8k, 10, 57, 137, 196 and 114) were found
to be enlarged, smooth and pale, with capsule stripping easily.
The organ No. 9 and a rough surface and the capsule was adherent
slightly. On section the cortex was slightly bulging and the
medulla reddened.

Microscopically the glomeruli were swollen, showed prolif-
eration of the epithelial and endothelial cells and almost filled
the Bowman’s space (Plate X). The cellularity of the glomerular
tuft was increased and was partly due to infiltration of leuco-
cytes. There were adhesions between proliferated tufts and
Bowman’s capsule in some glomeruli and was marked in Nos. 6k and
9 which also showed lobulations and crescent formation and foci
of lymphocytic infiltration. These two cases were diagnosed
as that of sub-acute glomerulo nephritis. In all the cases the
tubules were exhibiting granular degenerative changes.

Many authors consider that glomerulo nephritis is very rare
in the domesticated animals. Henschel 1925 (27) and Bloom 1937 (3)
ever encountered a clear cut case of glomerulo nephritis in dog.
But in the present study all the above cases showed a histological
picture typical of glomerulo nephritis. Similar picture was also
described by Smith et al 1960 (57) and Macdonald 1929 (39) who
encountered kidneys in which a considerable number of malpighian
bodies contained crescents and called this as cattarrhal glomerulo
nephritis
nephritis. McFadyean 1929 (39) observed that chronic glomerulonephritis is rare in the domestic animals and in the present study not a single case was found. According to Henchon 1923 (37), glomerular nephritis is one of the important forms in the horse.

(2) Acute Toxic Nephrosis:

Three kidneys (Nos. 111, 112 and 113) from two animals out of 500 showed on gross examination, pale patchy discoloration and slight enlargement. The capsule could be easily peeled off. On section the medulla and the cortex were found to be congested.

Microscopically there was acute congestion and conglutivale necrosis of some of the proximal convoluted tubules (Plate XI) with cloudy swelling of the remaining tubules. In some of the tubules the lining epithelium was exfoliated and there were hyaline casts in some of the tubules (Plate XII). The remaining renal parenchyma was not found to be much affected.

McFadyean 1929 (39) and Smith et al 1960 (57) described similar condition. They also observed fatty degeneration which was not encountered in the organs studied. According to latter the proximal convoluted tubules are affected probably due to their highly specialised epithelial cells. The tubular necrosis with extrusion of the contents of the tubules into the interstitial tissue which is a striking feature of the necrotic lesions of anoxic nephrosis as noted by Boyd 1962 (14) was not observed in the present cases, indicating the nephritis to be of toxic origin. Oliver 1944 (47) explained the localization of casts in distal convolutions and collecting tubules as "not by water absorption of
or acidity but by the high concentration of unknown 'x' substance and the low isoelectric point at which coagulation of the protein in the tubular fluid takes place. Contrary to Bloom 1943's (10) statement that all stages of regeneration of tubular epithelium are encountered in nephrosis, it was not found in the present histological study which suggested the acuteness of this condition.

(3) Acute Interstitial Nephritis (Focal and Diffuse):-

On microscopic examination this condition was observed in nine kidneys (Nos.44, 81, 91, 94, 96, 99, 104, 136 and 138). Both focal and diffuse forms were encountered. In one animal the lesion was bilateral while in the rest it was unilateral. In two cases (Nos.91 and 104) the other kidney showed lesions of the chronic type. In case No.136, the other kidney showed sub-acute glomerulo nephritis. The incidence of acute interstitial nephritis was 15% that of focal being 3.3% and of diffuse type being 11.7%.

In all these cases the affected organs were moderately enlarged and their surface was smooth and dotted with grayish white pin head sized spots. In section the spots were seen to be confined to the cortex. In addition, organ Nos.81 and 136 showed cysts 2 to 5 mm. in diameter. In all cases the capsule could be easily stripped.

The predominant histologic change in every organ examined was a heavy and widespread infiltration of the interstitial tissue by mononuclear cells. In organ Nos.44 and 81 the infiltration was focal throughout the kidney mostly in the cortex. In the remaining organs the infiltration was diffused but heavy in the cortex.
cortico-medullary zone. Many organs were congested and organ No.9 showed in addition glomerular haemorrhage. In organ No.104 there were many round lymphoid follicles (Plate AIII). No author has mentioned about the occurrence of such follicles.

Platt 1951 (49), Haradyan 1929 (39) and Bloom 1937 (8) described similar microscopic picture in their cases of acute glomerulonephritis. Henchen (26) was of the opinion that the inflammatory cells represent a type, intermediary between the lymphocytes and polyblasts, while, Neiberle et al 1951 (46) believed them to be histiocytes. Bloom 1956 (11) considers it erroneous to believe that all cells are mainly histiocytes. In the present study the incidence of diffuse form was three times more frequent than the focal form.

(4) Sub-acute Interstitial Nephritis:

Organ Nos.11, 20 and 135 showed unilateral sub-acute interstitial nephritis, focal in the latter two and diffuse in the former. The remaining kidney, in two cases, showed chronic nephritis and one showed hydronephrosis. The incidence of this condition was thus 5% to sample size.

Grossly two organs Nos.11 and 20 were having smooth surface and the remaining organ was firm to palpate and had a roughened surface, capsule adherent to it. On section organ No.11 was found to be hydronephrotic and in the remaining two, medulla was found to be congested. In all, greyish areas were found in the cortex.

Microscopically the predominant change in kidney Nos.20 and
and 126 was a periglomerular infiltration by the inflammatory cells and the proliferation of the connective tissue especially in the cortico medullary zone. In organ No.11 the infiltration was diffuse. In organ No.126 the capsule was thickened. Many tubules were showing atrophy and degeneration and the remaining cloudy swelling.

Similar microscopic picture is described by Bloom 1954 (11). The sub-acute interstitial nephritis might lead to chronic nephritis as it was already present in two of the three remaining kidneys. When compared to the chronic nephritis and acute interstitial nephritis, incidence of sub-acute interstitial nephritis was very much low.

(5) Chronic Interstitial Nephritis:

Seventeen animals out of 500 showed changes characteristic of chronic interstitial nephritis. In no animal was this condition bilateral. The remaining kidney in No.20 was showing sub-acute interstitial nephritis and in Nos.92 and 10 acute nephritis. Out of 17 animals six showed focal lesions and the remaining showed diffuse type of changes. The incidence of chronic interstitial nephritis was 3.4% to sample size and 3.4% to random sample.

Grossly no organ was found to be shrunken, contracted or atrophied, except organ No.80 which was abnormally small and measured 4.5x3x6.5 cms. and weighed only 10 gms. (Plate X1V) while second kidney showed compensatory hypertrophy and weighed 195 gms. Organ Nos.90, 120 and 121 were also very much hypertrophic and weighed 355, 220 and 210 gms. respectively. Organs Nos.7, 18, 31
90, 92, 93, 109 and 121 showed subcapsular retention cysts. Particularly organ No.109 was riddled with small tiny macroscopic cysts throughout the cortex (Plate XV). Out of 17 organs nine showed a rough surface. The kidney was firm, fibrous with scurs and difficult to cut. The capsule in all these cases was thickened and adherent. But in the remaining organs the surface was smooth and the capsules could be stripped easily.

On section the cortical markings were not prominent in many of the organs and the cortex was found to be slightly reduced in size. In four organs retention cysts were found also in medulla. Organ No.80 was very interesting because of the complete absence of medulla which was replaced by adipose tissue. The cortex was very think and fibrous and only at one place there was any semblance of the normal renal tissue.

Microscopically the most striking alteration was connective tissue proliferation (Plate XVI) both in the cortex and medulla and particularly in the cortico-medullary zone, with scattered areas of round cell infiltration. In some of the sections (Nos.80, 90, 92 and 103) the fibrous tissue was hyalinised. In kidney Nos.21, 25, 93, 103, 103 and 116 periglomerular fibrosis was seen (Plate No.XVII). Many of the glomeruli were collapsed, atrophied or destroyed (Plate XVIII). In some, adhesions were formed and in others there was great distention of Bowman's capsule (Plate XIX) with compression and collapse of the capillary tuft, while still others (Nos.7, 25, 80, 90, 102 and 103) were reduced to hyaline fibrous masses (Plate XX). Many of the tubules were atrophied and
and others showed irregular cystic dilatation with atrophic flattened epithelium, the lumen of which contained hyaline casts. Deposition of hemosiderin (Plate XX) was seen in some of the sections (Nos. 30 and 109). Sections (Nos. 7, 18, 20 and 109) were stained with Levaditi's to detect leptospirosis but no organisms were found. In one section No. 90 there was an attempted regeneration.

In organ No. 90, the pelvis was surrounded by a mass of connective tissue which showed hyalinisation. Beyond this, was a zone of adipose tissue of varying thickness. No medullary tissue was observed. Immediately after the adipose tissue, was a zone of large blood vessels with endarteritis obliterans and a thick connective tissue zone with atrophied cortical tissue. In the cortex only a small amount of normal renal tissue was present and was infiltrated with round cells indicating that the inflammatory process was still in progress. This kidney was very interesting as it was the only contracted and atrophied kidney with replacement of atrophied medulla by adipose tissue. McFadyean 1929 (39) stated that the pelvic fat increases in amount to compensate for the general atrophy of the kidney. The atrophy might be due to extensive contraction of the fibrous tissue that was newly formed.

In organ No. 109 the fibrosis was more marked in the medulla and every glomerulus was distended and formed into a cyst (Plate XIX). McFadyean 1929 (39) explained such cyst formation as the result of the obstruction to the free flow of urine in the tubules of the medulla.
In three specimens (Nos. 98, 120 and 181) the distribution of the connective tissue was interesting. It was present in much greater abundance throughout the medulla and the boundary layer. This condition was therefore classified as ascending type of chronic nephritis. McPadyen 1939 (39) recorded a similar case and stated that the invasion of the cortex appeared to have occurred from hilus.

In many of the cases in the present study it was interesting to note that the kidneys were found to be normal grossly even though they were showing chronic interstitial nephritis. Platt 1951 (49) stated that a serious degree of renal disease may be present without pronounced alteration in gross appearance of the kidney. According to Hurnells et al 1960 (53) "in chronic nephritis in pigs, kidneys often appear very pale and retain a proportionally large size than in other animals. Histologically, the fibrosis appears very late in the porcine kidney and hence the kidney with diffuse nephritis is slow to progress to a contracted state". In the present study not a single granular contracted kidney was encountered. McPadyen 1939 (39) was of the opinion that primary granular contracted kidney or senile contracted kidney which was common in man and carnivora is exceedingly rare in pigs.

In all the cases in which retention cysts were encountered there was extensive fibrosis of the medulla, indicating the cyst formation to be the result of obstruction to the flow of the urine through the medulla. 47% of the chronic nephritic kidneys showed retention cysts. Basset et al 1908 (8) were the first to notice the
the frequent occurrence of cysts in chronic nephritis. In the present study chronic nephritis was found to be very common (28.3%) in pigs.

\section*{Summary}

Available literature pertaining to the incidence and histopathology of kidney affections in domesticated animals is reviewed.

50 kidneys from 50 pigs out of 500 slaughtered at municipal slaughter house, showed abnormality on gross examination were subjected to further histological study.

The observations made on gross and microscopical study, the pathological conditions encountered were as follows:

(1) Three types of congenital anomalies were found.
   (a) Foetal lobulation was observed in one animal.
   (b) Abnormal shape of kidney was present in one animal.
   (c) Congenital polycystic kidney was observed in one animal.

(2) One animal was found to be having concretions.

(3) Kidneys of two animals were found to be infected with Stephanurus detatus and in five animals they were found to be affected with hydatid cysts. All the hydatid cysts were sterile.

(4) Hydrenephrosis was detected in three animals.

(5) Infarcts and scars were present in four animals.

(6) The commonest affection was found to be interstitial nephritis (48.3%) which was followed by glomerular nephritis (13.3%) and tubular nephritis (5%). An interesting finding was that many organs were found to be normal in size in chronic nephritis (28.3%). Retention cysts were observed in 47% of the chronic nephritic kidneys.
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Plate I: Kidney showing congenital abnormality. Medial border is convex, lateral border is concave and the kidney is elongated. Organ No. 98.

Plate II: Congenital polycystic kidney. Honeycomb appearance is distinctly seen. Organ No. 89.
Plate III: Compensatory hypertrophy of the right kidney (No. 90) and the polycystic left kidney (No. 89) is included for comparison.

Plate IV: Calculus in the renal cortex. Organ No. 101.
Plate V: Unilocular Hydatid cyst. Organ No. 49.

Plate VI: Section of the above kidney showing concentrically laminated cuticular membrane of the Hydatid cyst.
Plate VII: Hydatid cyst surrounded by fibrous tissue infiltrated with inflammatory cells and foreign body giant cells. Organ No. 129.

Plate VIII: Hydronephrosis showing the dilated pelvis and atrophy of the renal parenchyma. Organ No. .
Plate IX: Kidney showing irregular scars. Organ No. 110.

Plate X: Acute glomerulo nephritis. The swelling of the glomerulus due to proliferation of the epithelial and endothelial cells is distinctly seen. Organ No. 'wk.'
Plate XI: Toxic tubular nephritis. Coagulative necrosis of the proximal convoluted tubules is marked. Organ No. 113.

Plate XII: Acute tubular nephritis showing the exfoliation of tubular epithelium and hyaline casts in the lumen. Organ No. 112.
Plate XIII: Acute interstitial nephritis showing lymphoid follicles.
Organ No. 104.

Plate XIV: Contracted kidney.
Organ No. 30.
Plate XV: Chronic interstitial nephritis showing numerous small cysts in the cortex. Organ No. 109.

Plate XVI: Chronic interstitial nephritis showing connective tissue proliferation and round cell infiltration. Organ No. 116.
Plate XVII: Chronic interstitial nephritis showing periglomerular fibrosis and hyalinization. Organ No. 28.

Plate XVIII: Chronic interstitial nephritis showing periglomerular fibrosis with disappearance of the glomerulus and cystic dilatation of the Bowman's space. Organ No. 30.
Plate XIX: Chronic interstitial nephritis showing pressure atrophy of the glomerular tuft owing to accumulation of fluid in the Bowman's capsule.
Organ No. 109.

Plate XX: Chronic interstitial nephritis showing hyaline fibrous glomeruli and deposition of haemosiderin.
Organ No. 90.