THE OCCURRENCE AND SIGNIFICANCE OF RENAL LESIONS IN SWINE PROCESSED FOR FOOD

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ABSTRACT

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by James Henry Stewart

A study was made of grayish-white lesions observed during the post-mortem inspection of swine slaughtered for food purposes. The study included serological, cultural, and pathological examinations for determination of the occurrence and a possible etiological agent.

A review of the literature revealed a few references of experimental studies concerning renal lesions resulting from incidental bacterial infections, and many references on leptospiral micro-organisms as a causative agent of nephritis in swine.

The specimens collected for this study were obtained at a local food processing establishment during slaughtering operations.

The results of the microscopic agglutination-lysis test for leptospiral antibodies in one hundred swine sera samples, when compared with the pathological lesions in the kidneys of these same animals, failed to reveal a significant correlation.

Grossly, the renal lesions consisted of grayish-white

foci in the parenchymatous tissues. Microscopically, the lesions were an inflammatory process characterized by a leukocytic infiltration consisting principally of lymphocytes in the intertubular spaces.

An etiological agent responsible for the grayish-white renal lesion was not established on the basis of histopathological and cultural investigations.

The handling and consumption of swine kidneys exhibiting grayish-white foci may be a possible human health hazard. It is thought that these foci consisted of abnormal tissue and should be eliminated from the consumer's food supply.

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by

James Henry Stewart

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Dedicated to my wife,

Katharina

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I. INTRODUCTION

The importance of animal health in relation to a dependable meat supply has been recognized since the earliest history of man. The people of the United States are particular in regard to the quality and character of food consumed and object to consumption of animal tissues affected with a disease condition. Since an abundance of healthy animals is available to adequately supply meat for the diet, this objection should be respected.

Veterinarians engaged in meat hygiene are performing a basic function in a civilized society by striving to provide clean, wholesome, disease-free meat as a source of protein for the diet. A veterinarian who does not protect the human consumer from meat that might cause disease or that might otherwise be misrepresented is not performing an important function.

Veterinarians in meat hygiene must constantly strive to learn new facts and to re-evaluate known facts about diseases of animals for the meat consuming public. In the inspection of swine slaughtered for food purposes, small (pin-point) grayish-white foci are frequently observed in the kidneys. The study of these foci was initiated with two objectives in mind: (1) the occurrence, and (2) to

investigate the etiological, histopathological, and gross pathological aspects of the foci.

II. REVIEW OF THE LITERATURE

A. Introduction:

Several infectious diseases occur in swine in which only slight, or perhaps no, symptoms are apparent. Veterinarians performing post-mortem examinations of swine may observe gross lesions in the cortex and medulla of the kidney which apparently did not elicit clinical evidence of disease. Pathological changes will be more meaningful to a veterinarian performing a post-mortem examination when the infectious diseases responsible for lesions in the kidneys are more thoroughly studied.

Pathological evidence of an infectious disease process in a kidney is characterized by the micro-organisms creating the lesion. In the kidneys of swine containing small foci of infection in the cortex and medulla, a collection of leukocytes comprises an inflammatory exudate. This is the result of the infectious process and is referred to as interstitial nephritis.

Interstitial nephritis of swine caused by pathogenic micro-organisms may be identified by gross pathological, histopathological, and cultural techniques. A suppurative or a non-suppurative interstitial nephritis can result from an infectious process in the kidneys of swine. Examples of micro-organisms causing suppurative interstitial

nephritis are Corynebacterium pyogenes, Corynebacterium renale, Proteus vulgaris, and Escherichia coli. The prevailing leukocyte present in the inflammatory exudate of suppurative interstitial nephritis is the polymorphonuclear neutrophil.

Swine infected with leptospirae may have a non-suppurative interstitial nephritis as a result of the agent localizing in the kidneys. The kidney lesions can grossly resemble suppurative interstitial nephritis, but the composition of the inflammatory exudate will differ. The exudate in non-suppurative interstitial nephritis will consist of lymphocytes and reticulo-endothelial mononuclear cells.

B. Leptospirosis:

1. Gross pathology:

Leptospirae have a preference for the kidneys of an animal where localization and reproduction occurs in the tubules. The disease syndrome caused by the leptospirae is fundamentally the same regardless of the species of leptospirae or the species of animal involved. Only modifications in the virulence of the micro-organisms and the intensity of the clinical and pathological changes will occur (28) (14) (8).

Small grayish-white foci observed in the kidneys of swine examined during post-mortem inspection conducted at local slaughtering establishments were suggestive of

leptospirosis (5) (8) (14). The lesion may appear singly or scattered throughout the kidney substance, but the animal usually has not presented clinical symptoms (5) (8) (14) (21) (40).

The gross lesions are limited principally to the kidneys and appear either unilaterally or bilaterally in an affected animal. The grayish-white foci vary in size and number. The gross appearance of the lesion will range from barely discernible to about 5 mm. in diameter, and from one to many will be apparent in a single kidney. The site of the lesion is usually the cortex, less frequently in the medulla, of the kidney. The foci either appear even with or slightly elevated above the cortical surface (5) (8) (14) (10) (21) (40).

Adhesions between the capsule and the cortex usually do not occur and the capsule can be removed without difficulty (8) (10) (14) (21) (40). It has been reported in the literature that some kidneys may be roughened with small depressions and the capsules adhere to the cortical surface (8). In long standing chronic infections the kidneys have appeared shrunken and small bands of fibrous tissue are present on the surface of the cortex extending into the parenchyma (8).

The lesion is produced as early as seven days after experimental infection with Leptospira pomona and persists as an active inflammatory process for ten to fourteen

months (21) (29) (40). The significant features of the gross renal lesions in swine experimentally infected with Leptospira pomona are the early appearance and the relative severity of the lesion created by the micro-organism (40).

2. Histopathology:

Histopathological lesions of leptospirosis are present in the interstitial spaces, tubules, and glomeruli in the kidneys of affected swine. The pathology produced by the leptospiral micro-organisms is characterized by inflammatory and degenerative changes (8). The consistent inflammatory reaction is an infiltration of leukocytes into the interstitial spaces (5) (21) (29) (40). The leukocytic infiltration comprises an inflammatory exudate and consists principally of lymphocytes, plasma cells, and some macrophages. The inflammatory exudate also may be present in the perivascular spaces (21) (29) (40). The degree of inflammation in the cortex and medulla of a kidney is dependent on the leptospirae creating the pathological changes (8).

The predominant degenerative pathological change is hydropic degeneration of the kidney tubules (14) (40). The earliest change occurring is a slight degree of hydropic degeneration and occasional pyknosis of the nuclei of the tubular cells. In more severe hydropic degeneration, the nuclei are invisible or crowded to the surface and characterized by large, swollen, vacuolated tubular cells (14) (21) (40). The tubules within a foci of infection may be

destroyed resulting in physiologically inactive glomeruli (14) (21) (40).

Glomerular changes can be frequent, severe, or only minor (5) (14) (21). In minor changes, Bowman's capsule is surrounded by inflammatory cells and the subcapsular spaces may contain some proteinaceous material (5) (21). Hylanization of the glomerular tufts is evident (5) (21). Glomeruli may appear hypercellular due to the presence of lymphocytes and plasma cells (5) (21). Bowman's capsule in the more extensive pathological changes can be completely filled with a swollen glomerulus and adhesions may form between the capillary loop's and the parietal layer of the capsule (14). The glomerular tufts may even disappear leaving a distorted Bowman's capsule with an empty lumen (21). Some glomeruli may show evidence of undergoing fibrosis with thickening of Bowman's capsule resulting in obliteration of the capsular space and loss of separation between the capsule and glomerular tuft (14) (29).

3. Serology:

Serological surveys to reveal the incidence of leptospiral antibodies in the serum of swine have been conducted in many areas of the world. The interpretation of the serological findings has been difficult because a correlation between the actual antibody titers present and its diagnostic significance is not fully understood in evaluating leptospiral infections (19) (35) (5) (8) (9) (13) (24) (28) (32) (48).

Swine experimentally infected with Leptospira pomona had a serum antibody titer detectable at dilutions of 10^{-2} and 10^{-3} eight days after inoculation and the maximum antibody response (10^{-7} to 10^{-8}) occurred three to four weeks post inoculation (28). The antibody titer declined to 10^{-2} to 10^{-5} four or five months later (28). However, antibody titers (10^{-2} to 10^{-3}) have persisted in swine experimentally infected with Leptospira pomona for one year (28).

Swine probably are actively infected with Leptospira pomona when the serum agglutination-lysis titers are present in dilutions of 10^{-4} or higher (28). A potential hazard to livestock and human health exists during an active infection because the affected animal may become a renal carrier and transmit the micro-organisms within an environment (4) (6) (8) (10) (25) (26) (28) (48) (50).

Agglutination-lysis reactions in the dilutions of 10^{-1}, 10^{-2}, and 10^{-3} can be interpreted with different diagnostic meanings in relation to leptospiral infections in swine (5) (24) (28) (32) (35) (8) (9) (19) (13) (48). These low antibody titers may indicate inactive infection in which the antibody titer has decreased, or a recently acquired active infection where the antibody titer has not obtained its maximum level (5) (19) (24) (28) (35) (32).

The epizootiology of leptospirosis is complicated by the ability of the leptospirae to become localized in the kidney tubules of swine and rats with a low or absent

serum antibody titer (5) (8) (18). The isolation of Leptospira icterohemorrhagiae from the kidneys of rats whose sera did not contain demonstrable antibody titers has been accomplished (18). Leptospira pomona have been recovered from the kidneys of swine whose sera did not react or reacted at the lower dilutions when tested with the plate agglutination or agglutination-lysis tests (5) (8).

Piglets do not contain agglutination-lysis titers against a leptospiral serotype at birth because the maternal antibodies are withheld from the feti in utero by the placental barrier (8) (28). However, antibodies are acquired from the colostral milk and piglets will reveal, soon after suckling, approximately the same antibody titer as the sow (8). In the absence of an active leptospiral infection, a progressive decline in the piglets acquired antibody titer occurs (8).

Disappearance of antibody titers in sera of animals with active leptospiral infections may occur upon administration of antibiotic drugs (18). The leptospiral micro-organisms present in the liver, spleen, and interstitial kidney tissues may be destroyed without affecting the micro-organisms localized in the kidney tubules. These animals can remain carriers capable of transmitting the leptospiral micro-organisms (18). Other phenomena that may influence the development of an antibody titer are the age and number of leptospirae in the infective dose, and neutralization

by the micro-organisms of the circulating antibody (28) (29) (32).

C. Pyelonephritis:

1. Gross pathology:

Veterinary literature describing pyelonephritis in swine is limited because a greater emphasis has been directed toward the disease condition in other animals, especially cattle and horses. The term pyelonephritis signifies an inflammatory process occurring in the pelvis and parenchyma of the kidney (44). Pyelonephritis is usually of an infectious nature and several genera and species of micro-organisms are implicated as etiological agents responsible for the pathology produced (23) (44). An extensive and diffuse necrotizing inflammatory process usually characterizes the disease condition (17) (20) (23) (34) (44) (45).

The inflammatory process is frequently bilateral in an affected animal, but an occasional unilateral infection does occur (17) (23) (45). The size, color, and texture of an affected kidney will vary in gross appearance dependent upon the severity, extent, and duration of the pathological changes resulting from the infection. The size of a kidney may be normal or greatly enlarged with very little kidney tissue present (17) (23) (34) (45). The cortical surface can be mottled with grayish-white foci

which contain an inflammatory exudate (34) (44) (45) (49).

The texture of the kidney substance can vary from normal to firm depending upon the degree of fibrosis that resulted from the inflammatory process (23) (34) (44) (45). The pelvis of an affected kidney may contain a non-odorous gray or yellow purulent material, often mixed with fibrin, small blood clots, necrotic tissue, and calcareous matter (17) (23) (34) (44) (45) (49). The purulent material is tenacious in consistency and will distend the pelvis when a large enough quantity is present. The papillae of the renal pyramids can become necrotic in the course of the inflammatory process (17) (23) (34). The medullary and cortical areas of an affected kidney may possess abscesses and hemorrhages that vary in size from microscopic to macroscopic (17) (23) (34) (44) (49). The capsule of an affected kidney may be adherent to the cortical surface and will be difficult to remove (23) (34) (49).

2. Histopathology:

A histopathological examination will reveal an inflammatory exudate, degenerative, and proliferative pathological changes in the kidney tissues affected by the inflammatory process (34) (44) (45). Polymorphonuclear leukocytes usually will be the major component of the exudate and in conjunction with lymphocytes, mononuclear phagocytes, as well as other inflammatory elements, will constitute a purulent exudate (34) (44) (45). The exudate may appear

to be diffusely located among the kidney tubules in a more or less radial direction (34) (44).

Degenerative pathological changes of the kidney tubules are associated with the inflammatory process that occurs in an affected kidney. Microscopically, a kidney infected with pyelonephritis will reveal pathological changes such as cloudy swelling, fatty degeneration, and necrosis of the epithelial cells comprising the kidney tubules (34) (44) (45). These changes observed on histopathological examination may be due to a reaction between the kidney cells and a toxin derived from the growth of the micro-organism responsible for the pathological syndrome (44).

A fibrous proliferative tissue response accompanies the inflammatory process in the localized infected areas of the kidney. The tissue reaction is primarily a pericapsular proliferation that encircles Bowman's capsules with one or several layers of fibrotic tissue. The glomerulus usually is not invaded by fibrous tissue, but a proliferation may extend into it. An extension of the intertubular connective tissue of the medulla and thickening of arteries and arterioles may occur in the immediate vicinity of the inflammatory process (34) (44) (45).

III. MATERIALS AND METHODS

A. Collection Procedures:

The specimens for this study were obtained from swine slaughtered at a food processing establishment located in East Lansing, Michigan. The swine were selected at random from 16 separate slaughtering operations. The health status, environmental conditions, and the animal husbandry practices were not known prior to the collection of the various specimens. Variations in the age, breed, or sex were not considered a factor in the selection of the swine. The writer performed an ante-mortem and post-mortem examination on all of the swine that were slaughtered. None of the animals presented for slaughter exhibited clinical symptoms of a disease condition.

1. Blood:

All blood samples were obtained from the anterior vena cava after the swine had been shackled and placed on an overhead track in the eviscerating room. The blood was collected in dry vials immediately after severance of the anterior vena cava and allowed to clot. Humane slaughtering techniques were not employed to produce surgical anesthesia before severance of the anterior vena cava.

2. Bacteriological and Histopathological Specimens:

The swine were placed in a scalding vat following

exsanguination. The hair and scurf became less firmly fixed which facilitated its removal by a dehairing machine. Each carcass was suspended on an overhead dressing track after removal of the hair and scurf for evisceration and inspection. Carcasses that were not rejected after examination of the head and viscera continued along the dressing track and were split and the kidneys removed from their capsules. The kidneys were inspected and those with grayish-white foci were removed from the carcass. The affected portions were excised and placed in a container (8 ounce "dispo-cup"*) for bacteriological examination. Suitable specimens were likewise immediately placed in 4 ounce screw cap jars containing ten per cent neutral formol-saline solution for fixation for histopathological examination. Approximately 30 minutes elapsed from the time of exsanguination to collection of the specimens.

B. Laboratory Procedures:

1. Blood Study:

The microscopic agglutination-lysis test for leptospiral antibody titers was conducted on the serum from 100 swine. Leptospira pomona (strain Johnson) and Leptospira icterohemorrhagiae live antigens and the serums were mixed

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*Disposable Specimen Cup. Distributed by the Scientific Products. A Division of American Hospital Supply Corp., Evanston, Ill.

in dilutions of 10^{-1}, 10^{-2}, and 10^{-3}. The tubes containing the serum mixed with live antigen were incubated for two hours at 37 C. in a thermostatically controlled water bath before reading the test. A microscope, with an Abbe condenser into which a star diaphram was fitted, was employed to produce a modified dark-field type of illumination. The degree of agglutination was recorded as <1+ (less than 25%), 1+ (25%), 2+ (50%), and 3+ (75%).

2. Tissue Studies:

The kidneys of all swine were inspected during the post-mortem examination. When grayish-white foci were observed on the cortex or occasionally in the medulla, tissue sections were taken for histopathological studies. The staining procedures used were as follows: hematoxylin and eosin, Brown and Breen's method for bacteria in tissues (1), and Warthin-Starry's technique for spirochetes (1).

3. Isolation of Bacterial Micro-organisms:

Tryptose agar (Difco) with defibrinated blood constituting a final concentration of seven per cent was used in attempts to isolate bacterial micro-organisms from the grayish-white kidney lesions. Samples from the lesions were streaked on this medium and incubated for 24 hours at 37 C. The presence or absence of bacterial growth was observed at the end of the incubation period. In the absence of growth, further bacteriological culturing was not undertaken.

4. Isolation of Leptospirae:

The isolation of leptospirae from the kidneys containing grayish-white foci was attempted by a culture medium technique (5) (9) (25). This tissue was placed in approximately 20 ml. of 0.85% sodium chloride solution and macerated in a Waring blender. Three or four drops of the emulsion produced was inoculated into a culture tube containing Stuart's Difco medium with rabbit serum added to a final concentration of ten per cent. The culture tubes were incubated for four weeks at 30 C. and the presence of leptospirae was investigated at weekly intervals by a microscopic dark-field examination.

IV. RESULTS

During the post-mortem inspection of swine at a local food processing establishment, it was found that a number of the kidneys examined contained grayish-white foci in the cortices. The gross lesions observed resembled the characteristic lesion produced in the kidneys of swine experimentally infected with Leptospira pomona (8) (10) (21) (40). However, under field conditions other etiological agents may produce a similar type of lesion (8).

The examination of 200 kidneys revealed a relatively high incidence of grayish-white foci in the cortices. The percentage of kidneys with foci observed in various slaughter groups ranged from 50.00 to 11.54. Table 1 presents data showing that 41 kidneys had 1 to 2 foci and that 13 kidneys had 10 to 20 foci. The capsules stripped easily from the cortical surfaces of the kidneys. Some of the lesions were slightly raised above the cortical surface, others were not, and ranged in size from barely visible to 4 mm. in diameter. When sectioned saggitally the grayish-white foci were seen extending into the medulla of some kidneys.

The results of the microscopic agglutination-lysis test conducted on 100 swine sera are presented in Tables 2 and 3. Leptospira pomona and Leptospira icterohemorrhagiae live antigens were used in testing the sera for antibody

titers. Agglutination-lysis reactions were detectable in 19 of the sera. Of these, 12 reacted in a dilution so low that they were considered insignificant, and 7 reacted in dilutions indicative of possible exposure to a leptospiral micro-organism (Table 3) (8) (5) (28) (19) (9) (13) (24) (32) (35).

The results of the histopathological examination of the kidneys containing grayish-white foci is presented in Table 4, and Figures 1-8. The examination consistently revealed an interstitial nephritis and an inflammatory exudate comprised predominantly of lymphocytic cells. There was also evidence of degeneration in areas infiltrated by the inflammatory exudate.

The results of attempts to isolate a microbial species as an etiological agent are presented in the data (Tables 5-8). The isolation and identification of a micro-organism responsible for the inflammatory process was not accomplished in this study.

Table 1. The incidence of grayish-white foci in the kidneys of swine examined on post-mortem inspection

Date	Number of Kidneys Examined	Number of Kidneys with Foci	Kidneys with 1-2 Foci	Kidneys with 10-20 Foci	Per Cent of Kidneys with Foci
5-23-61	32	10	5	5	31.25
6-6-61	16	7	5	2	43.75
7-25-61	52	6	6	0	11.54
9-12-61	24	9	7	2	37.50
9-25-61	6	3	2	1	50.00
10-3-61	8	2	2	0	25.00
10-17-61	24	7	5	2	29.17
10-24-61	24	4	4	0	16.67
12-19-61	14	6	5	1	42.86
Total	200	54	41	13	27.00

Table 2. Serological results of swine serum samples to two leptospiral serotypes

Serotype	Swine Sera Tested	Swine Sera Negative	Swine Sera Reacting
L. pomona	100	92	8
L. icterohemorrhagiae	100	89	11

Table 3. Serological results of swine sera samples reacting to two leptospiral serotypes

Serotype	Number of Sera Samples	Dilutions									
			10^{-1}			10^{-2}			10^{-3}		
		<1+	1+	2+	3+	1+	2+	3+	1+	2+	3+
L. pomona	3	+	-	-	-	-	-	-	-	-	-
	2	-	+	-	-	-	-	-	-	-	-
	2	-	-	+	-	-	-	-	-	-	-
	1	-	-	+	-	+	-	-	-	-	-
L. icterohemorrhagiae	7	-	+	-	-	-	-	-	-	-	-
	2	-	-	+	-	-	-	-	-	-	-
	1	-	-	+	-	-	+	-	-	-	-
	1	-	-	-	+	+	-	-	+	-	-

Table 4. Results of the histopathological examination of swine kidneys containing grayish-white foci

Date	Number of Kidneys Examined	Interstitial Nephritis	Predominant Cell in the Inflammatory Exudate	Degeneration of the Kidney Parenchymatous Tissues
5-23-61	5	Yes	Lymphocyte	Yes
6-6-61	3	Yes	Lymphocyte	Yes
7-25-61	4	Yes	Lymphocyte	Yes
9-12-61	4	Yes	Lymphocyte	Yes
9-25-61	3	Yes	Lymphocyte	Yes
10-3-61	2	Yes	Lymphocyte	Yes
10-17-61	4	Yes	Lymphocyte	Yes
10-24-61	3	Yes	Lymphocyte	Yes
12-19-61	3	Yes	Lymphocyte	Yes
Total	31			

Figure 1

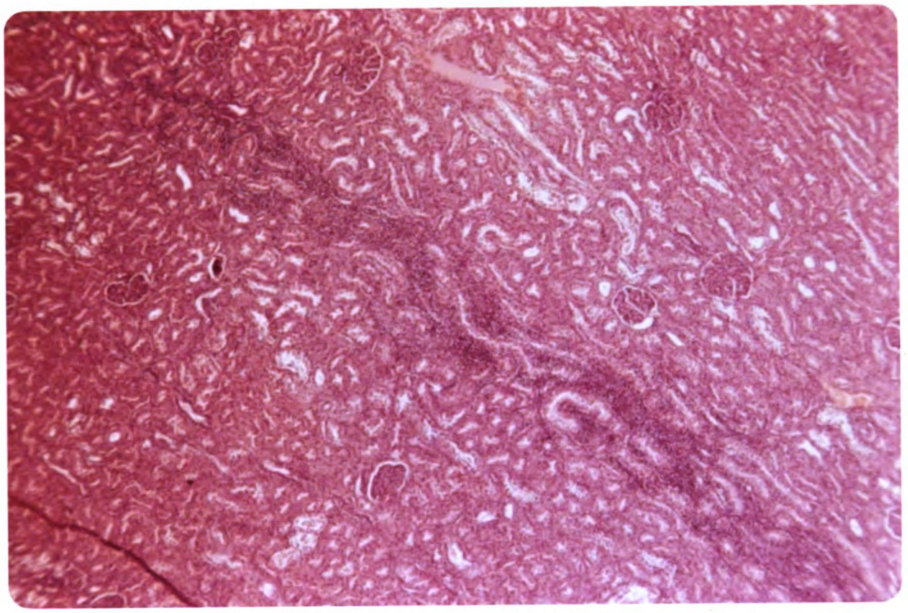
x 31

A diffuse infiltration of inflammatory cells in the cortex of a swine kidney. H & E.

Figure 2

x 125

A higher magnification of Fig. 1 depicts the diffuse infiltration of the inflammatory exudate and degeneration of the convoluted tubules. H & E.



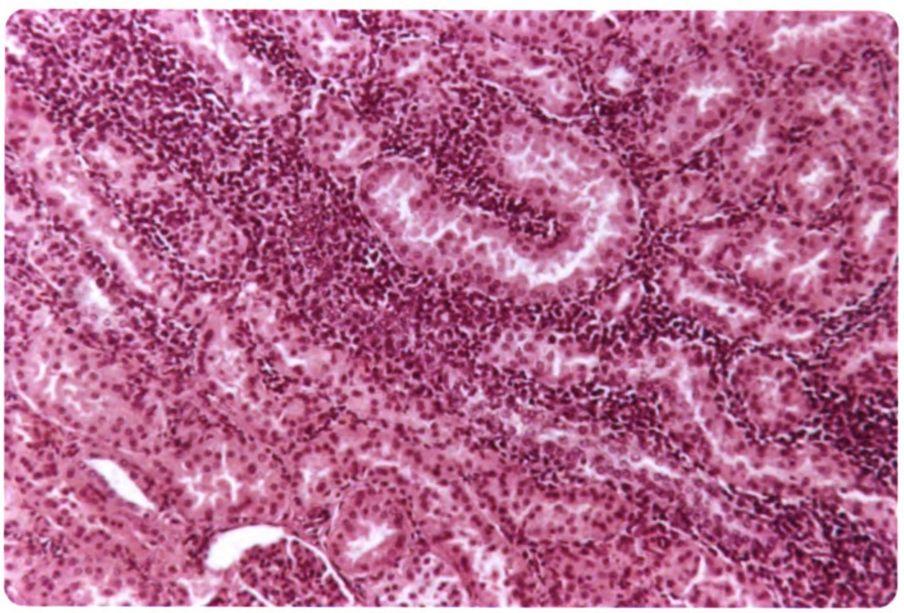


Figure 3

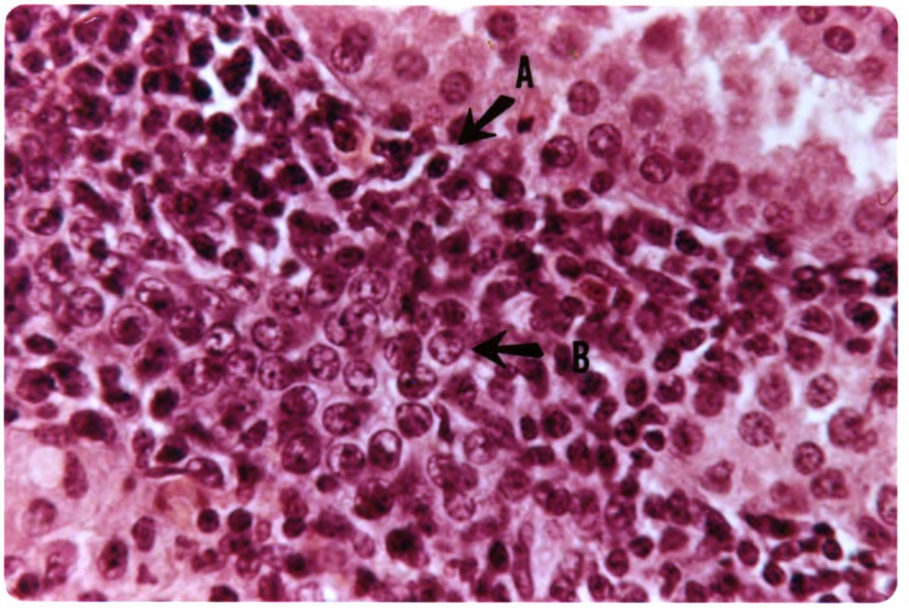
x 500

A higher power of the preceding two photomicrographs reveals a focus of mononuclear cells in the affected area. The predominant cell types are lymphocytes (A) and mononuclear phagocytes (B). H & E.

Figure 4

x 31

A subcortical infiltration of inflammatory cells (A) in a swine kidney. H & E.


A
B

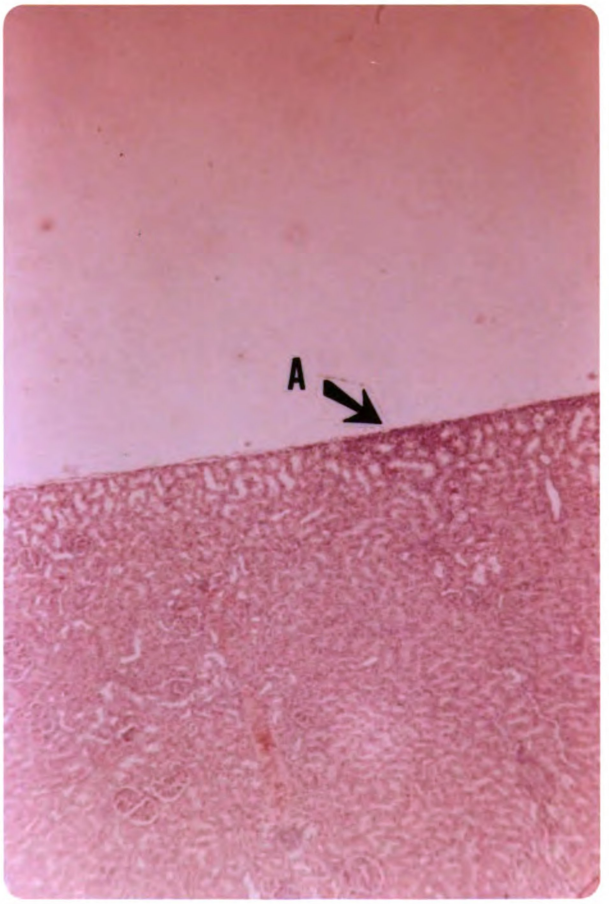

A

Figure 5

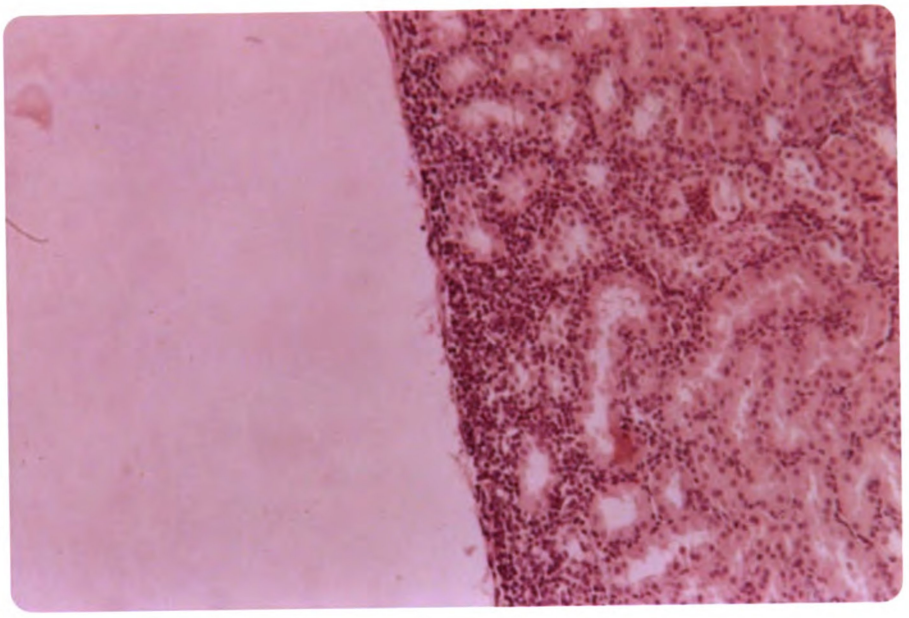
x 125

Greater magnification of Fig. 4 shows subcapsular degenerative changes in the area of inflammation. H & E.

Figure 6

x 31

A peritubular focal infiltration of inflammatory cells in a swine kidney cortex. H & E.



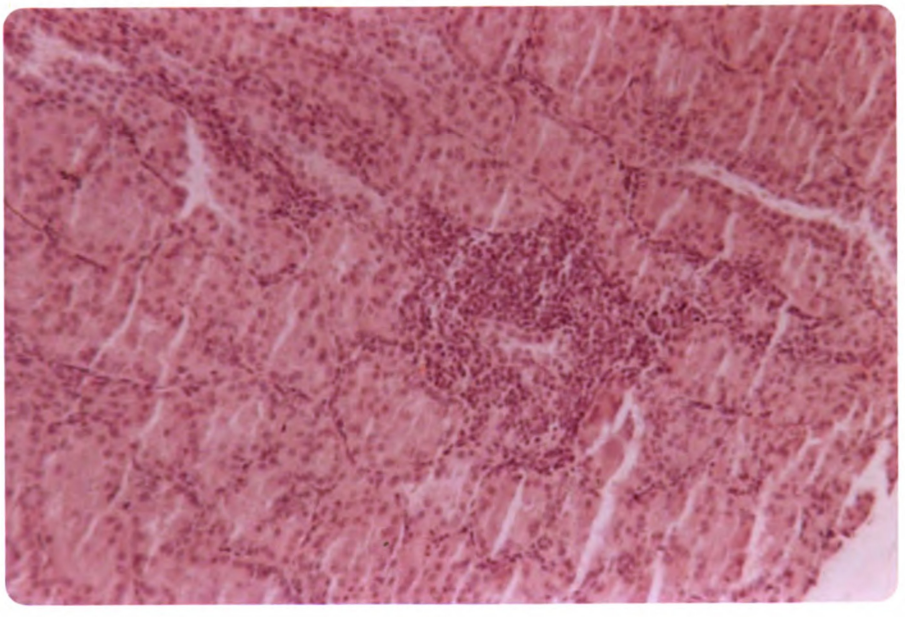


Figure 7

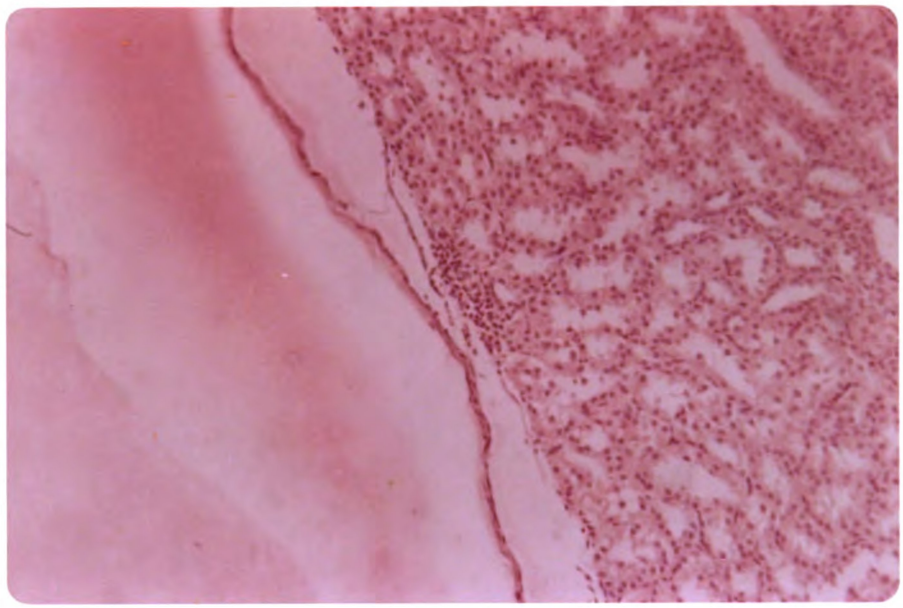
x 31

A subacute, subcapsular focus of inflammatory cells in a swine kidney. The separation of the capsule from the kidney tissue is an artifact. H & E.

Figure 8

x 500

A higher power of Fig. 7 exhibits the focus of lymphocytes (A) in the subcapsular area. H & E.



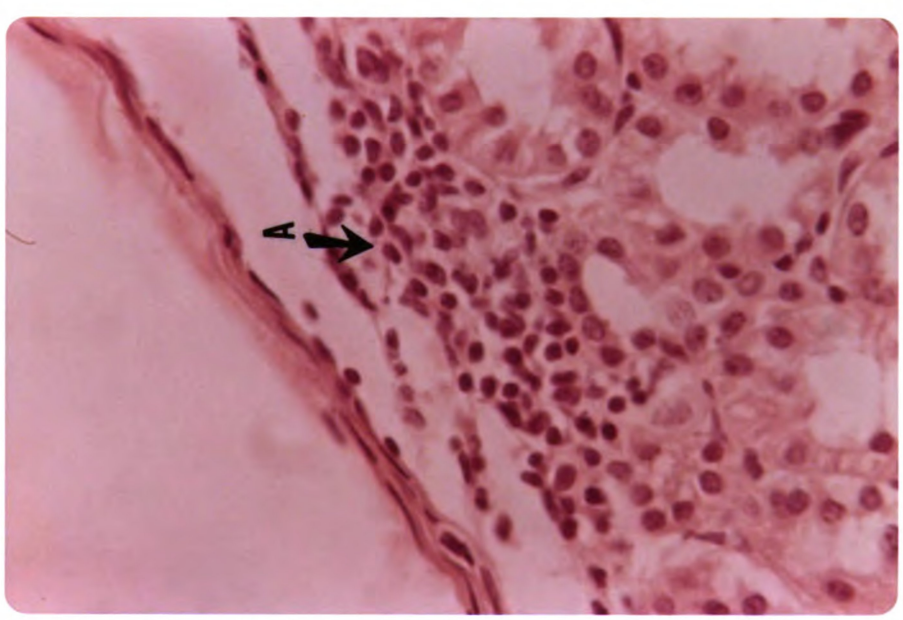

A

Table 5. Results of bacterial cultures of swine kidneys containing grayish-white foci

Date	Number of Kidneys Cultured	Bacteriological Findings
5-23-61	3	Negative
6-6-61	1	Negative
7-25-61	4	Negative
9-12-61	3	Negative
9-25-61	2	Negative
10-3-61	2	Negative
10-17-61	2	Negative
10-24-61	1	Negative
12-19-61	2	Negative
Total	20	

Table 6. Results of Brown and Breen's staining method for bacteria in tissues

Date	Number of Kidneys Examined	Bacterial Findings
5-23-61	5	Negative
6-6-61	3	Negative
7-25-61	4	Negative
9-12-61	4	Negative
9-25-61	3	Negative
10-3-61	2	Negative
10-17-61	4	Negative
10-24-61	3	Negative
12-19-61	3	Negative
Total	31	

Table 7. Results of the Warthin-Starry stain for leptospirae in tissues

Date	Number of Kidneys Examined	Leptospirae in the Tissues
5-23-61	5	Negative
6-6-61	3	Negative
7-25-61	4	Negative
9-12-61	4	Negative
9-25-61	3	Negative
10-3-61	2	Negative
10-17-61	4	Negative
10-24-61	3	Negative
12-19-61	3	Negative
Total	31	

Table 8. Results of tissue culture attempts to isolate leptospirae

Date Cultured	Number of Kidneys Cultured	Leptospiral Isolations
1-9-62	4	Negative
1-16-62	4	Negative
1-23-62	3	Negative
2-6-62	4	Negative
2-13-62	2	Negative
3-13-62	2	Negative
3-27-62	2	Negative
Total	21	

V. DISCUSSION

During the post-mortem examination of clinically normal swine slaughtered in a local food processing establishment grayish-white renal lesions were observed. The gross and histopathological lesions resembled an inflammatory process created by leptospiral micro-organisms. Grossly, the lesions observed were small grayish-white foci varying in size and number which were limited to the parenchymatous tissues of the kidneys, especially the cortices. A suppurative process characterized by a tenacious exudate was not evident upon gross examination. The microscopic lesions consisted of a leukocytic infiltration principally in the intertubular spaces of the cortex and medulla, although it occurred in perivascular and periglomerular areas. The lesion was usually focal, but in several kidneys it was rather diffuse. The unit of the nephron in an affected area was either undergoing degeneration or had entirely disappeared. The findings were similar to the pathological processes produced in pigs experimentally infected with Leptospira pomona (8) (10) (21) (40).

A comparison of the histopathological and serological results (Tables 2 and 3) obtained using Leptospira pomona and Leptospira icterohemorrhagiae live antigens failed to indicate definite correlation. The interpretation

of the serological findings is difficult because the diagnostic value of antibody titers in the lower dilutions is not completely understood in leptospiral infections in swine (5) (8) (9) (13) (19) (24) (28) (32) (35). If the reactions of 25% agglutination or less at the dilution of 10^{-1} are eliminated and only the higher reactions considered several explanations are possible. Certain factors such as the age, number, and virulence of the leptospirae in the infective dose may influence the height of the titer in a pig that becomes infected (32). Antibiotic therapy could eliminate the leptospirae from a pig except in the kidney tubules and a loss of a demonstrable blood titer might occur (18). Piglets are born without antibodies against Leptospira pomona and can acquire them from the colostral milk of the sow. However, immunity acquired in this manner will decline (8). When the disease is endemic most of the pigs probably become infected during early life and a low antibody titer may be present at the time of slaughter (37). The serological results could be an indication that infection may have been caused by leptospirae other than Leptospira pomona or Leptospira icterohemorrhagiae (39). The comparatively low antibody levels in the pig sera tested may have been due to any one, or a combination, of the aforementioned possibilities.

It has been reported in the literature that 20% of 114 swine sera collected at a slaughtering establishment

contained antibodies against Leptospira pomona, but 50% of these animals revealed histopathological lesions indicative of leptospirosis (8). Microscopic evidence of a leptospiral infection was found in 86% of 338 cattle received at the Plum Island Animal Disease Laboratory during a one year period. A correlation between the serological and histopathological results was not evident (39).

In this study, the kidneys from 100 swine had a 27% incidence of grayish-white foci in the parenchymatous tissues without significant serological reactions to Leptospira pomona and Leptospira icterohemorrhagiae antigens. These observations suggest that the incidence of infection with leptospirae may be higher than indicated by the microscopic agglutination-lysis test.

The results of three procedures presented in the data (Tables 4-6) suggest that the kidney lesions did not contain an intact bacterial micro-organism: (1) the persistent absence of suppuration in the tissue sections stained with hematoxylin and eosin, (2) the failure to obtain growth of a bacterial species from lesions cultured on tryptose blood agar, (3) the negative results of the Brown and Breen's staining method for bacteria in tissues.

The tissue cultures used in this study failed to isolate a leptospirae from the grayish-white renal foci. However, it was judged that the abnormal tissue observed in the swine kidneys should be eliminated from the consumer's food supply.

Veterinarians engaged in meat hygiene are striving to provide a meat supply free from diseases injurious to the health of the consumer. Leptospirae in animals intended for human food have the ability to localize and reproduce in the kidneys for long periods of time (4) (8) (28) (36) (37). Research evidence on swine leptospirosis and the observations herein presented indicates there may be a correlation between the grayish-white foci and the leptospirae and further research appears necessary.

VI. SUMMARY AND CONCLUSIONS

Grayish-white renal foci were seen during the post-mortem examination of swine conducted at a local food processing establishment. The abnormal tissue was located in the cortex and medulla of the kidney. Microscopically, the lesions were a leukocytic infiltration in the intertubular spaces and consisted principally of lymphocytes.

The sera of 100 swine were tested by the microscopic agglutination-lysis test against Leptospira pomona and Leptospira icterohemorrhagiae live antigens. The antibody titers were relatively low and difficult to interpret in relation to exposure to leptospirae.

The research evidence appearing in the literature and the observations presented in this study suggest that the grayish-white renal foci may indicate a higher incidence of leptospiral infections than is revealed by the microscopic agglutination-lysis test.

The procedures used in this study did not confirm a specific etiological agent responsible for the grayish-white renal lesion.

The grayish-white foci consist of abnormal tissue and for this reason such tissue should be eliminated from the normal channels of food production.

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