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Gross and microscopic lesions of 230 Kansas greyhounds

Polly Schoning, Laine A. Cowan

Abstract. Two hundred thirty greyhounds from Kansas were submitted to Kansas State University for necropsy to identify and document their diseases. Sex distribution was 124 females (1 spayed) and 106 males (1 castrated). Age range was 5 days-150 months. The mean body, heart, and liver weights for adult dogs (> 12 months) were 30 kg, 367 g, and 1,019 g, respectively. Greyhounds were divided into six groups by histories: skeletal injuries, 24 (10%); nonskeletal injuries, 23 (10%); old age ($\bar{x} = 89$ months), 25 (11%); poor performers, 83 (36%); sick, 68 (30%); and no history, 7 (3%). Gross lesions by system were as follows: skin, 85 (37%); lung, 13 (6%); skeletal, 36 (16%); gastrointestinal, 55 (23.9%); central nervous system, 3 (1%); thyroid, 5 (2%); cardiovascular and hemopoietic, 36 (16%); spleen, 30 (13%); male reproductive, 13 (12%); kidney, 9 (4%); liver, 7 (3%); and no gross lesions, 23 (10%). Correlation of the histories to the gross lesions showed that poor performers had the largest number with no gross lesions, the skeletal injury and sick groups had more gastrointestinal changes, and the nonskeletal injury and sick groups had most of the male reproductive abnormalities. Microscopic lesions of the 6 tissues examined were as follows: lung, 21 (9%); small intestine, 15 (6.5%); brain, 6 (3%); heart, 9 (4%); kidney, 57 (24.3%); liver, 26 (11.3%); and no microscopic lesions, 131 (57%). Correlation of the histories to microscopic lesions showed that poor performers had the largest number with no microscopic lesions, the sick group had the largest number of lesions of the lungs, small intestine, brain, heart, kidney, and liver, however, the old group had renal lesions almost as often as the sick group.

Greyhounds are unique among canids because their major function is to win races rather than to act as companions. The greyhound industry is big business. Approximately 48,000 greyhounds are whelped each year. Of those, 39,000 are individually named and registered by the National Greyhound Association (G. Guccione, personal communication), usually just prior to the dogs going to the track. Because greyhounds are commercial dogs, diagnosis and treatment must be cost effective. For that same economic reason, greyhounds may be euthanized and disposed of without necropsy. Furthermore, the competitive nature of the greyhound business prevents owners and trainers from sharing ideas on the details of feeding, management, and training, all of which could influence the disease process in greyhounds.

One reference³ contains 1,012 citations of articles pertaining to the greyhound. Of those articles, 182 are related to disease per se and only 110 of those are limited to greyhounds rather than considering all dogs. Our survey is the first to categorized diseases of greyhounds, grossly and microscopically, by history. The objective of this project was to identify and document diseases of greyhounds and to identify those areas that need further research.

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Materials and methods

During the spring and summer of 1991, 1,230 dead Kansas greyhounds were transported to Kansas State University for necropsy. Greyhounds came from 35 different Kansas farms. All except 3 were submitted by veterinarians, rather than directly by owners. Two hundred one cases (88%) came from 2 Abilene veterinarians. They recorded the sex, color, tatoos, weight, owner, time of death, and history for each greyhound. Greyhounds were euthanized prior to transportation to Kansas State University.

For consistency, all greyhounds were necropsied by 1 pathologist (PS). Heart and liver weights were recorded. Samples of lung, liver, kidney, spleen, mesenteric lymph node, brain, gracilis muscle, heart, skin, sciatic nerve, aorta, pancreas, small intestine, adrenal gland, thyroid, and testicle or ovary were fixed in 10% neutral formalin and embedded in paraffin. Tissues were collected for microbiologic and fluorescent antibody tests as indicated.

Sections of heart, lung, kidney, liver, small intestine, and brain from all dogs were cut at 6 μ m and stained with hematoxylin and eosin for light microscopic examination. Sections of other organs were embedded in paraffin for examination at a later date.

Data were entered into a spreadsheet using the following categories: greyhound number (1-230), veterinarian, owner, age in months, sex, history, body weight, heart weight, liver weight, intestinal parasites, additional diagnostic tests, and gross lesions by systems- skin, respiratory, skeletal, gastrointestinal, endocrine, central nervous, circulatory, splenic, and "other," including liver and kidney. Also categorized were microscopic lesions of brain, heart, lung, liver, kidney, and small intestine.

Table 1. Number (%) of male and female greyhounds for each of 6 history groups.

Sex	Histories						Total
	Skeletal injury	Nonskeletal injury	Old	Poor performers	Sick	No history	
Male	11 (45.8)	14 (60.9)	3 (12)	37 (44.6)	39 (58)	2 (28.6)	106 (46.1)
Female	13 (54.2)	9 (39.1)	22 (88)	46 (55.4)	29 (42)	5 (71.4)	124 (53.9)

Results

History. Histories were seldom complete, often vague, and often given to the veterinarian by a kennel person who did not know much about the animal. For simplification, the greyhound histories were divided into the following 6 categories: skeletal injuries, non-skeletal injuries, old age, poor performers, sick, and no history.

The skeletal injury category (24 greyhounds, 10%) consisted of dogs with old or recent fractures, avulsions, or luxations.

Nonskeletal injuries (23 greyhounds, 10%) included those dogs that were described as being "hurt." That category included descriptions such as weak in the rear legs, injured at track, lame, could not finish the race, pulled muscle, back end problem, old injury, injured triceps, and muscle problems in the hind limbs.

The old age category included 25 greyhounds (11%), 22 of which were females. The mean age was 89 months (7.5 years), with a range of 48-150 months. Most of the greyhounds in this category were euthanized because of reproductive problems, including infertility, small litter size, or poor mothering.

Poor performers (83 greyhounds, 36%) were those with histories including "too slow," "fighters," "poor conformation," "too small," "can't run," "not trainable," "not racing material," "unable to compete," "spooks," "turns head when racing," and "won't race."

Sick greyhounds included those that were either

brought in for diagnosis and/or treatment and those that died suddenly. Sixty-eight (30%) were in this category, and 12 of those died suddenly.

No histories were available for 7 greyhounds (3%).

Sex, age, and weights. The number of males and females for each history group is given in Table 1. Of the 230 greyhounds, there were 124 females (1 spayed) and 106 males (1 castrated). They ranged in age from 5 days to 150 months. Among the adult dogs (112 months of age) the mean age was 37 months (SD = 28 months). For adult dogs, the mean body weight was 30.0 kg (SD = 3.2 kg), the mean heart weight was 367 g (SD = 53 g), and the mean liver weight was 1,019 g (SD = 187 g).

Gross lesions. In general, the greyhounds had deep thoracic cavities and small, compressed, abdominal cavities. Abdominal fat was scant. The stomach and intestines were usually empty. Notably, the skeletal muscles were dark red to purple and the greyhounds exuded a large amount of blood, including those that were necropsied 24 hours after death.

Three hundred lesions were recorded and are summarized by history groups in Table 2. Parasites and the same lesion in multiple organs were not included in the count.

Skin lesions were seen in 85 greyhounds (37%). Forty-three greyhounds (19%) had hair loss of the lateral thighs (bald thigh syndrome), 3 had ulcers of the extremities associated with Alabama Rot, 1 had calcinosis circumscripta at the distal ends of both scapular

Table 2. Number (%) of gross lesions for each organ/system listed by history for 230 greyhounds.

Organ/system	Histories						Total
	Skeletal injury (n = 24)	Nonskeletal injury (n = 23)	Old (n = 25)	Poor performers (n = 83)	Sick (n = 68)	No history (n = 7)	
Skin	8 (33.3)	13 (56.5)	6 (24)	30 (36.1)	22 (3.1.9)	6 (85.7)	85 (37)
Respiratory	1 (4.2)	0	2 (8)	2 (2.4)	8 (12)	0	13 (6)
Bones	20 (79.2)	0	1 (4)	3 (3.6)	12 (17.7)	0	36 (16)
Gastrointestinal	7 (29.2)	2 (8.7)	2 (8)	8 (9.6)	35 (50.7)	1 (14.3)	55 (23.9)
Thyroid	0	1 (4.3)	4 (16)	0	0	0	5 (2)
Circulatory	0	6 (26.1)	8 (32)	5 (6)	15 (22.1)	2 (28.6)	36 (16)
Reproductive	1 (4.2)	4 (17.4)	1 (4)	3 (3.6)	15 (22.1)	0	24 (10.4)
Spleens	1 (4.2)	2 (8.7)	8 (32)	11 (13.3)	8 (11.6)	0	30 (13)
Kidney/liver	1 (4.2)	1 (4.3)	3 (12)	4 (4.8)	7 (10.3)	0	16 (7)
No gross lesions	1 (4.2)	2 (8.7)	2 (8)	17 (20.5)	1 (1.4)	0	23 (10)
Total lesions	39	29	35	66	122	9	300

spines, and 1 had a 6- x 4- x 4-cm neoplasm on its right thorax. Thirty-seven greyhounds had skin lesions, including old wounds, patchy hair loss, excessive scaling, ulcers, pigmentation, and hair from areas other than the lateral thigh.

Pulmonary macroscopic changes were identified in 13 greyhounds (6%). Three had severe anthracosis, 3 had edema, 3 had hemorrhages, 2 had bronchopneumonia, 1 had palpable pulmonary ossification, and 1 had multiple small pleural plaques thought to be mineralization.

Skeletal changes were seen in 36 greyhounds (16%). Half of those had fractures, of which 4 were old and 11 were recent, as determined by the history and/or necropsy. Ten recent fractures involved the front and rear limbs equally; 1 involved multiple skull fractures. Additional skeletal problems included brachygnathia inferior in 4, osteochondritis dissecans in 2, disc spondylitis in 1, spondylosis in 1, nonunion fracture of the femur in 1, severe synovitis and arthritis involving multiple joints and associated with a septicemia in 1, and a tentative clinical and gross diagnosis of osteosarcoma in 1. Eight greyhounds had old injuries that were not classified further. Those lesions were characterized by enlargement and fibrosis usually of a hock. Two greyhounds had 14 pairs of ribs, with the 14th pair usually cord-like.

Gastrointestinal changes, other than intestinal parasites, were seen in 52 greyhounds (23%). The stomach or small intestine of 14 greyhounds had foreign bodies, including cloth, strings, plastic, bones, sand, plant material, and hair. The intestinal tracts of 14, 3, and 9 greyhounds contained watery, abnormally dry, or bloody feces, respectively. Two greyhounds had intussusceptions of the jejunum, 2 had oral ulcers, 2 had stomach ulcers, and 2 had diphtheritic membranes of the small intestine. One greyhound had chewed off the lateral side of its tongue following surgery for bilateral sialoceles, and 1 puppy had a dilated esophagus.

Two unusual intestinal changes were seen. Two greyhounds had firm strictures of 2-5 cm of the colon, and 3 greyhounds had diverticula of the ileum or duodenum. The diverticula contained mucus and mineralized material. In 1 greyhound, the ileum was occluded at that site. The intestine cranial to the occlusion was severely dilated and filled with brown watery, putrid ingesta.

Parasites, both intestinal and external, were seen in 66 greyhounds (29%): 41 (18%) had tapeworms, 7 had roundworms, 4 had hookworms, 10 had fleas, and 2 had ticks.

Central nervous system lesions were limited to 3 greyhounds (1%). One greyhound had a purulent exudate in its cranium, 1 had a purulent exudate in the thoracic spinal column, and 1 had severe hyperemia/

congestion of meningeal vessels and petechiae of the brain.

Gross lesions of the thyroid were seen in 5 greyhounds (2%) and consisted of enlargement in 1, nodules in 3, and a cyst in 1. Adrenal glands varied greatly in size and shape. In 2 greyhounds, adrenal glands were recorded as small. After formalin fixation, the glands were incised sagittally before embedment. Cortical nodular hyperplasia was seen in several glands.

Lesions of the cardiovascular and hemopoietic systems were seen in 36 greyhounds (16%). The most common change was endocardiosis in 24 greyhounds. The 12 other lesions included 3 cases each of icterus and anemia; 2 cases with white plaques on the left endocardium; and 1 case each of abscesses of the right atrium in a greyhound with a persistent fever of unknown origin, ossification of the aortic ring in a 30-month-old greyhound, mineralization of a small coronary vessel, and a 2-mm yellow pericardial nodule. Hemorrhages were seen in several greyhounds and were recorded for systems affected.

Spleens were usually large and blood filled, with their increased size attributed to euthanasia techniques. However, 30 spleens (13%) had additional changes. Eleven had siderotic plaques, and 9 had unusual shapes and/or papillary projections. Seven spleens had evidence of past injury recognized by splenic constriction and/or omental adhesions. One greyhound had an acutely ruptured spleen with hemoperitoneum, orange discoloration of the intestinal serosa, and icterus. One spleen had a 4-cm nodule midway on its parietal surface. Another spleen was severely contracted and had multiple red and white plaques.

Gross lesions of the reproductive tract were limited to males, with 2 exceptions. One female had a 0.5-cm parauterine nodule and 1 had recently whelped and had a prominent placental site. Twenty males had lesions, and 2 of these had more than 1 lesion. Thirteen greyhounds (12% of males) had retained testicles: right was retained in 6 greyhounds, the left in 6 greyhounds, and both in 1 greyhound. One retained testicle had a 0.5-cm round focus thought to be a neoplasm. In another greyhound, both testicles were descended, but the left 1 was two-thirds the size of the right 1. The scrotum of the castrated male contained a large hematoma associated with the castration. Two greyhounds had lacerations of the penis or prepuce.

The final category of lesions included those changes that did not fit the other categories and/or were not numerous. Excessive body fat was recorded for 11 greyhounds: 3 were males and 8 were females; 8 were >4 years old. Nine greyhounds had renal lesions, which ranged from subjective evaluation of size to 2 renal infarcts. Liver changes were noted for 7 greyhounds. Those changes included variation in color, a cyst, an

Table 3. Number (%) of microscopic lesions for 6 organs listed by history for 230 greyhounds.

Organ	Histories						Total
	Skeletal injury	Nonskeletal injury	Old	Poor performers	Sick	No history	
Lung	2 (8.3)	1 (4.3)	0	5 (6.0)	13 (19.1)	0	21 (9)
Small intestine	0	0	0	1 (1.2)	14 (20.6)	0	15 (6.5)
Brain	1 (4.2)	1 (4.3)	0	0	4 (5.9)	0	6 (3)
Heart	1 (4.2)	1 (4.3)	3 (12)	0	4 (5.9)	0	9 (4)
Kidney	3 (12.5)	6 (26.1)	16 (64)	9 (10.8)	22 (32.4)	1 (14.3)	57 (24.8)
Liver	0	1 (4.3)	6 (24)	1 (1.2)	18 (26.5)	0	26 (11.3)
No lesion	17 (70.8)	14 (60.9)	8 (32)	68 (81.9)	18 (26.5)	6 (85.7)	131 (57)
Total lesions	7	10	25	16	75	1	134

enlarged lobe, and hemiation of the gall bladder and a small piece of liver into the thoracic cavity. Three greyhounds showed pancreatic changes: 1 had severe diffuse hemorrhage, 1 was hypoplastic, and 1 was pale and rubbery.

Twenty-three (10%) of the greyhounds had no gross lesions.

Microscopic lesions. Brain, heart, lung, liver, kidney, and small intestine were examined for each of the 230 greyhounds. Additional organs were examined when needed to make a diagnosis, depending on the history and/or gross lesions. Microscopic lesions are summarized by history groups in Table 3.

Brain lesions were identified in 6 (3%) greyhounds. Only 2 of those dogs had had a history of central nervous system signs. The predominant change was a non-suppurative meningitis. Conversely, 2 dogs that were fluorescent antibody positive for distemper had no morphologic lesions of the brain.

Heart lesions were identified in 9 (4%) greyhounds. Two greyhounds had subendocardial fibrosis, which had been seen grossly as white foci. Two greyhounds had severe muscular necrosis and mineralization, 1 had severe suppurative myocarditis and epicarditis, and 1 had mineralization of several small vessels. Three cases were not identified grossly, but microscopically, 1 had *Sarcocystis* and 2 had occasional small foci of inflammatory cells.

Lung lesions were present in 21 (9%) of the dogs. Bronchopneumonia or interstitial pneumonia occurred in 15 of those cases. Two dogs had focally collapsed alveoli, 2 had hemorrhage and thrombi, and 2 had hemosiderin-laden macrophages (heart failure cells). Common pulmonary findings not recorded as lesions included carbon in various amounts and areas of ossification.

Liver lesions were seen in 26 (11.3%) of the dogs. Hepatocytes were vacuolated in 14 dogs, accumulations of inflammatory cells and/or fibrosis of the portal areas occurred in 3 dogs, and microabscesses were ob-

served in 5 dogs. Also, 3 livers showed pigment (hemosiderin), and 1 had a cyst.

Kidney lesions were present in 57 (24.8%) dogs. Chronic glomerulonephritis characterized by thickening of the glomerular and capsular basement membranes usually without inflammatory changes was seen in 37 of the 57 dogs. Chronic inflammatory changes, including chronic-active interstitial nephritis, were seen in 11 dogs. Also, 3 kidneys had infarcts, 2 had granulomas, and 5 had tubular degenerative changes.

Lesions of the small intestine were seen in 15 (6.5%) of the dogs. Enteritis characterized by dilated, debris-filled crypts was seen in 10 dogs, with 3 of those having changes characteristic of parvovirus enteritis. Parasites not recognized grossly were seen in 3 dogs, lymphoplasmacytic enteritis in 1, and a diverticulum filled with proteinaceous material and mineral in another.

No significant microscopic lesions of the 6 organs examined were seen in 131 (57%) of the dogs.

Microbiologic and fluorescent antibody tests. Additional diagnostic tests were done on 23 greyhounds. Two electron microscopic examinations of feces for virus particles were negative. Ten fluorescent antibody tests for parvovirus and/or distemper gave 2 positive results for distemper. Four hemagglutination tests for parvovirus were interpreted as negative. Microbiologic examination was done on 20 greyhounds; 15 were intestinal, and of those, 7 showed *Salmonella*. The other 5 examinations were of skin, joints, or meninges.

Discussion

Although this is the first survey of greyhound diseases, orthopedic, muscular, and racing injuries have been reported.^{1,2,8,9,12} The most common skeletal injury of the greyhound is fracture of the central tarsal bone, almost always of the right leg.^{4,8} Skeletal injury of forelegs is reported to involve the carpus of the right¹² or left⁸ leg. The recent fractures seen in the present study were equal in distribution- 5 for the front and 5 for the rear legs. The most common muscular injury re-

ported is of the gracilis muscle, especially of the right leg.^{1,9}

Physical work capacity is thought to be associated with relatively large hearts. Greyhound heart size is usually 0.9-1.3% of body weight,¹⁴ and the heart weight: body weight ratio is 1.25 for greyhounds versus 0.80 for mixed breed dogs.¹³ Heart weight : body weight ratios were the same in both trained and untrained greyhounds.¹¹ Actual heart weights from another study⁷ averaged 357 g for 23 males that weighed an average of 288 kg¹³ 316 g for 17 females that weighed 24.8 kg,¹³ and 396 g for 7 greyhounds that weighed 26.8 kg. In the present study, the hearts averaged 367 g and body weights averaged 30 kg, with a heart weight : body weight ratio of 1.22, which is similar to those previous findings.

Overall, 54% of the greyhounds were female and 46% were male. The two history groups that did not fall within that male : female ratio were the nonskeletal injury and old groups. The nonskeletal injury group was mainly male (61%), and the old group was mainly female (88%).

Because the poor performers group was closest to normal, we expected this group to have the smallest percentage of gross lesions for all systems. This group did have the largest percentage of dogs with no gross lesions and the smallest percentage with reproductive abnormalities. However, most (79.5%) of the greyhounds had at least 1 lesion.

Conversely, we expected the sick group to have the largest percentage of lesions for all systems. That group did have more lesions for the respiratory, gastrointestinal, and reproductive systems. It also had the smallest percentage (1.4%) of greyhounds with no lesions.

Skin changes (37%) were numerous and somewhat evenly distributed for all history groups. As expected, bone lesions were far more common in the skeletal injury group. Splenic, thyroid, and circulatory changes occurred in the old group more frequently than in the other groups.

Microscopic lesions for the lung, small intestine, brain, and liver were more common in the sick group than in the other groups. However, microscopic lesions of the kidney and heart were more common in the old group than in the sick group. No significant lesions were seen in a majority of greyhounds from the skeletal injury, nonskeletal injury, and poor performers groups. However, only 6 organs were routinely examined for this report.

Gastrointestinal changes were diagnosed more frequently grossly than they were microscopically, probably because changes can be segmental and the chance of obtaining a sample of the lesion from 3.6 m of small intestine is small. However, more lesions of the lung,

brain, heart, kidney, and liver were found microscopically than were identified grossly.

Chronic glomerulonephritis with or without lymphoplasmacytic infiltration of the interstitium was the most common change identified microscopically and was seen in 64% of the old group. This percentage seems high, but we do not know how it compares with occurrence in other breeds of dogs >4 years of age. Also, we do not know if clinical signs or abnormal blood chemistries were present.

Skin lesions were seen in 37% of the greyhounds. Bald thigh syndrome⁶ was a common finding in all history groups, occurring in 20% of the dogs. The disease is characterized by a loss of hair on the lateral thighs often extending to the medial thighs and ventral abdomen. The cause for this disease is unknown, but is thought to be endocrine.⁶ Alabama Rot,⁵ the most intriguing or mystifying disease specific to greyhounds, is characterized by skin ulcers of the extremities and often renal failure. Cause and pathogenesis are unknown, although *Staphylococcus*¹⁰ infection has been suggested as a possible cause.

Other lesions that were common and, therefore, of importance to greyhound owners included intestinal foreign bodies, retained testicles, bloody intestinal contents (some with *Salmonella*), endocardiosis, and healed splenic injuries. Intestinal parasites were present in 23% of the dogs, suggesting that parasite control is inadequate. Microscopic findings of carbon and ossification of the lungs suggest damage from the environment and/or exercise-induced trauma.

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