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From the Department of Medicine, College of Veterinary Medicine, Helsinki, Finland.

THE HEREDITARY NATURE OF CANINE PANCREATIC DEGENERATIVE ATROPHY IN THE GERMAN SHEPHERD DOG

By

E. Westermarck

WESTERMARCK, E.: *The hereditary nature of canine pancreatic degenerative atrophy in the German shepherd dog.* Acta vet. scand. 1980, *21*, 389—394. — The incidence of pancreatic degenerative atrophy (PDA) was investigated in 59 German shepherd dogs from two kindred. The male progenitors were the same in both kindred. In the four litters of the first kindred the incidence of PDA was 24 % (10 dogs out of 41), and there was at least one affected dog in each litter. When one of the litter bitches, later affected with PDA, was mated with one of the obligate carriers of PDA, one of the resultant seven offspring has so far been found to suffer from PDA. In the second kindred when a PDA-affected bitch and a clinically healthy male (heterozygote) were mated, two of the resultant six offspring were found to suffer from PDA.

These results indicate that PDA is a disease inherited as an autosomal recessive trait, although the possibility of dominant inheritance with incomplete penetrance cannot be excluded.

pancreatic degenerative atrophy; German shepherd dog; recessive inheritance.

Pancreatic degenerative atrophy (PDA) in dogs resembles the exocrine pancreatic insufficiency in mice and the pancreatic insufficiency (Shwachman syndrome) in man, both recessive diseases (*Shwachman & Holsclaw* 1972, *Pivetta & Green* 1973). PDA occurs mostly in the German shepherd dog (*Freudiger* 1976, *Hill* 1978) and it is caused by a deficiency of the pancreatic hydrolases. The affected dogs become emaciated although they eat voraciously. The stools are bulky, pale, soft and malodorous. The dogs are usually one to four years old when displaying the first symptoms of the disease. Both sexes seem to be equally affected (*Köhler & Stavrou* 1967, *Weber & Freudiger* 1977). The

main pathological findings in PDA dogs are a general inanition and an atrophic pancreas which histologically contains very little glandular tissue with a few acinar cells. A quantitative analysis of pancreatic hydrolase activity in the gut or faeces has been used to confirm the PDA diagnosis (*Haverback et al.* 1963, *Bush* 1975, *Batt et al.* 1979). A new test where the faecal protease activity is analyzed after feeding crude soybean, has proved to be a reliable and simple method to confirm the diagnosis of PDA (*Westermarck & Sandholm* 1980).

Many authors have suggested that PDA is a hereditary disease (*Anderson & Low* 1965, *Geyer et al.* 1968, *Freudiger, Köhler & Stavrou, Hill*). *Weber & Freudiger* followed back by pedigree analysis 19 clinically obvious PDA cases as far as 1918. All the dogs had a common ancestor and 18 of them had been inbred more than once on his descendants. On the basis of this inbreeding and comparing the results with a control group of dogs it was assumed that an autosomal recessivity was responsible for the occurrence of PDA. The present paper describes the hereditary nature of PDA in 59 German shepherd dogs from two kindred.

MATERIAL AND RESULTS

Faecal samples of 350 suspected PDA dogs of various breeds were examined for faecal protease activity with the Radial-enzyme-diffusion method (RED) during 1977—1979 (*Westermarck & Sandholm* 1980). Fifty-five German shepherd dogs, two collies and one dachshund proved to be PDA-positive. The pedigrees of the affected German shepherd dogs revealed that several of the dogs were related to each other. Two kindred were selected for further examination.

The pedigrees of the kindred are presented in Fig. 1; both kindred had the same male progenitors.

The owners of the German shepherd dogs of this material were interviewed to check for any symptoms of PDA. Whenever PDA was suspected a detailed examination of the dog was undertaken. The diagnosis of PDA was based on the dogs' history, clinical examination and laboratory and necropsy findings. Eighteen dogs of these two kindred had already died or had been euthanized for various reasons before the investigation and therefore, in four cases, the diagnosis of PDA was based purely on the typical history of PDA. In these four dogs the symptoms

appeared at the age of two to four years. They became emaciated in spite of a voracious appetite. Coprophagia was noticed in all cases. The stools were voluminous, greasy and rancid smelling. In spite of their poor condition the dogs remained lively for a long time. All the four dogs died or were euthanized about one year after the symptoms had appeared.

The laboratory tests were based on the measurement of faecal proteolytic activity with the RED method during repeated samplings. Dogs affected with PDA have negative faecal protease activity also during the crude soybean test when fed with 1 g/kg crude soybean powder twice daily together with normal food and the faecal protease activity is analyzed two days afterwards (*Westermarck & Sandholm*). Necropsy findings confirmed the PDA diagnosis in eight cases.

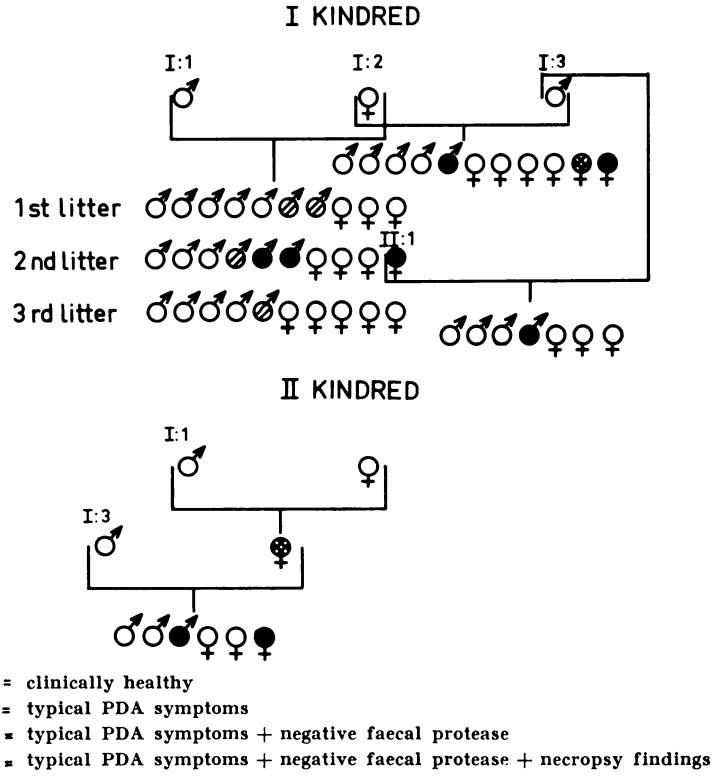

Figure 1. Pedigrees of two kindred of 59 German shepherd dogs with a high incidence of pancreatic degenerative atrophy (PDA) and the criteria of the diagnosis. The male progenitors are the same in both kindred.

Kindred data. The first kindred (Kindred I, Fig. 1) shows that the healthy bitch I:2, who died at the age of six years, produced four litters, 41 offspring. She was mated three times with the male I:1 (imported from Sweden, died at the age of 12 years) and once with the male I:3 (imported from the Federal Republic of Germany, at present nine years old). The bitch and both the males she was mated with showed no signs of PDA. Ten of the 41 offspring (three females and seven males) have so far suffered from PDA. There was at least one case of PDA in all the four litters. The incidence of PDA was 24 % (10 dogs from 41). Only two of the descendants have had offspring, one of these, the bitch II:1, displayed PDA symptoms after whelping. As indicated in Fig. 1, this bitch as well as her mother were mated with the male I:3. So far, at the age of three years one of the seven dogs in this litter has been PDA-diagnosed, but two litter mates were euthanized at one year of age due to severe hip dysplasia. The second kindred (Kindred II) (Fig. 1) shows one PDA-affected bitch offspring of the male I:1, which was mated with the male I:3. At present, at the age of two years, two of the six dogs in this litter are PDA-positive.

DISCUSSION

The incidence of PDA (24 %) in the four litters of the female progenitor of the first kindred and the occurrence of at least one affected dog in every litter suggests that PDA is inherited as an autosomal recessive trait supporting the suggestion of *Weber & Freudiger* (1977). The possibility of autosomal dominant inheritance with incomplete penetrance, however, cannot be excluded. The female progenitor and both of the males showed no signs of PDA and thus they are considered to be carriers of the PDA gene. When one bitch puppy, later found to be PDA-positive, was mated with one of the obligate carriers of PDA, it resulted in a litter where to date one dog has developed PDA (three years of age). Only one affected offspring from a mating of a homozygote and heterozygote parent is less than expected on the basis of autosomal recessive inheritance, but the figure may change when the dogs get older. As mentioned above, two of the litter mates were euthanized before the age when the symptoms of PDA are usually apparent.

In the second kindred when a homozygote and heterozygote parent were mated, two of the six offspring were found to be

PDA-positive. It is possible that more dogs will become affected later as the dogs are still so young.

The incidence of PDA in the whole population of the German shepherd dog in Finland has not been evaluated. *Freudiger* (1976) has reported that in his clinic the PDA morbidity in this breed is 8 ‰ and it is assumed that in Finland PDA is a much more common disease than suspected.

REFERENCES

Anderson, N. V. & D. G. Low: Juvenile atrophy of the canine pancreas. Anim. Hosp. 1965, *1*, 101—109.

Batt, R. M., B. M. Bush & T. J. Peters: A new test for the diagnosis of exocrine pancreatic insufficiency in the dog. J. Small Anim. Pract. 1979, *20*, 185—192.

Bush, B. M.: Veterinary Laboratory Manual, 1st Ed., p. 323—328, Heinemann Medical Books, Ltd. London 1975.

Freudiger, U.: Epidemiologie, Ätiologie, Klinik und Diagnose der chronischen exokrinen Pankreasinsuffizienz. (The epidemiology, etiology, clinical signs and diagnosis of chronic pancreatic deficiency). Prakt. Tierarzt 1976, *57*, 300—314.

Geyer, S., Br. Bibrack & T. Hänichen: Zur Klinik und Pathologie von Pankreaserkrankungen beim Hund. (The clinical signs and pathological findings of pancreatic diseases in the dog). Kleintier-Prax. 1968, *13*, 17—24.

Haverback, B. J., B. J. Dyce, P. J. Gutentag & D. W. Montgomery: Measurement of trypsin and chymotrypsin in stool. Gastroenterology 1963, *44*, 588—597.

Hill, F. W. G.: Pancreatic disorders of dogs. Vet. Ann. 1978, *18*, 198—203.

Köhler, H. & D. Stavrou: Ein Beitrag zur Pankreas Atrophie beim Hund. (Further information of pancreatic atrophy in the dog). Dtsch. tierärztl. Wschr. 1967, *74*, 150—153.

Pivetta, O. H. & E. L. Green: Exocrine pancreatic insufficiency: A new recessive mutation in mice. J. Hered. 1973, *64*, 301—302.

Shwachman, H. & D. Holsclaw: Some clinical observations on the Shwachman syndrome. Birth Defects, Orig. Art. Ser. 1972, *8*, 46—49.

Weber, W. & U. Freudiger: Erbanalytische Untersuchungen über die chronische exokrine Pankreasinsuffizienz beim Deutschen Schäferhund. (A genealogical study of chronic exocrine pancreatic deficiency in the German Shepherd dog). Schweiz. Arch. Tierheilk. 1977, *119*, 257—263.

Westermarck, E. & M. Sandholm: Faecal hydrolase activity as determined by radial enzyme diffusion — a new method for detecting pancreatic dysfunction in the dog. Res. vet. Sci. 1980, *28*, 341—346.

SAMMANFATTNING

Ärftligheten av degenerativ atrofi i bukspottskörteln hos schäferhunden.

Ärftligheten av degenerativ atrofi i bukspottskörteln (PDA) undersöktes i två släktlinjer av schäfer, omfattande totalt 59 hundar. Stamfäderna var desamma för båda linjerna. Stammodern i den ena linjen hade fyra valpkullar med totalt 41 valpar, av vilka 10 valpar insjuknade i PDA. I vardera släktlinjen fanns en tik som led av PDA. Dessa parades med en kliniskt frisk (heterozygot) han. I avkomman inom den första släktlinjen har tillsvidare en av sju valpar insjuknat i PDA, medan i den andra släktlinjen två av sex valpar har drabbats av PDA.

Föreliggande resultat tyder på att PDA är en sjukdom som nedärvs genom en autosomal recessiv gen, även om man inte helt kan utesluta möjligheten att det handlar om en dominant ärftlighet med ofullständig penetrans.

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Reprints may be requested from: E. Westermarck, the Department of Medicine, College of Veterinary Medicine, P.O. Box 6, 00551 Helsinki 55, Finland.