

Canine Hip Dysplasia: Breed Effects

S. W. MARTIN, K. KIRBY AND P. W. PENNOCK *

SUMMARY

This paper is a refinement of previous studies in that only suitably radiographed dogs were included in the data base. The rate of hip dysplasia varied widely by breed from five percent in siberian huskies to eighty-three percent in english bulldogs. There was a significant difference in the prevalence of dysplasia within at least two breeds; golden retrievers and old english sheepdogs. Physical size *per se* did not appear to be an important determinant of hip dysplasia.

RÉSUMÉ

L'influence de la race dans la dysplasie de la hanche, chez le chien

Cette étude représente une amélioration sur les antérieures, parce que ses résultats ne se basent que sur des chiens radiographiés d'une façon adéquate. La fréquence de la dysplasie de la hanche varia beaucoup, selon la race; par exemple, elle n'atteignit que 5% chez le Husky sibérien, comparativement à 83% chez le Bulldog anglais. On nota une différence appréciable, relative à cette anomalie, chez au moins deux races, à savoir le Retriever doré et le vieux Berger anglais. La taille *per se* ne sembla pas représenter un facteur déterminant d'importance pour cette anomalie.

INTRODUCTION

Canine hip dysplasia (CHD) appears to be a complex multifactorial disease

(1, 3, 5, 6, 10). Although large breeds of dogs have the greatest risk, it has not been possible to stereotype any particular breed as far as the risk of CHD is concerned.

Estimates of the relative rate of CHD in different breeds of dogs have been made, most frequently using case records from private or institutional veterinary clinics (3, 8, 9). In these studies, certain breeds of dogs had higher risks of CHD, although the comparison groups used in such studies may have given a false impression of the magnitude of that risk. For example, all dogs seen at ten veterinary schools in a defined time period have been used as the comparison (control) group (8). However, many breeds of dogs are not routinely radiographed for CHD and including these dogs in the control group may underestimate the true risk of CHD and bias the estimates of risk by breed.

The purpose of the present study was to estimate the prevalence rate and the relative risk of CHD by breed, sex, and year using data from dogs radiographed at the Ontario Veterinary College (OVC) during 1970-1978.

MATERIALS AND METHODS

The study was based on records of dogs subjected to pelvic radiography between January 1970 and December 1978. Most of the radiographs were of dogs submitted for certification of CHD status. Also included were radi-

ographs of dogs with a "normal pelvis"; after establishing that most radiographs were taken in a manner to permit the diagnosis of CHD if it were present. For this purpose, a random sample, of size 30, was taken of all cases of "normal pelvises" and all had radiographs taken in the ventralsdorsal view used to diagnose CHD.

For each dog, data on the following variables were recorded from the OVC radiology section records:

- i) owner number (an arbitrary number given to each individual owner),
- ii) dog number (indicating the number of dogs having the same owner),
- iii) year (the year the dog was initially radiographed for CHD at OVC),
- iv) age, to the closest half year (dogs less than six months were considered to be 0 years),
- v) sex (male or female, not indicating neutering),
- vi) breed (coded according to the Veterinary Medical Data Program (VMDP) and OVC coding system for breeds),
- vii) right hip grade (severity of CHD — normal to grade IV — in the right hip) and
- viii) left hip grade (severity of CHD — normal to grade IV — in the left hip).

Statistical Analyses

Cross-tabulations of the data according to breed, age, sex, year and owner were made using the Statistical Package for Social Sciences (SPSS) (7). Additional analyses based on logarithm of odds ratios or trends of proportions (2) were conducted using personal programs written in "A Programming Language" (APL).

Initially, the proportion positive for CHD by breed was compared with the proportion of dogs of "mixed breeds" positive for CHD. Then, for all breeds represented by twenty or more dogs,

*Department of Veterinary Microbiology and Immunology (Martin), Fourth year veterinary student (Kirby) and Department of Clinical Studies (Pennock), Ontario Veterinary College, University of Guelph, Guelph, Ontario N1G 2W1.

the effect of breed was determined with simultaneous control for possible distorting effects of age and year. To do this, for each of these breeds, 2 x 2 tables were constructed for each age-time period grouping. Each table portrayed the rate of CHD for a specific breed and the rate for "other breeds". Summary results were obtained using the logarithm of odds ratios method. Three age groups were used: group one, dogs less than or equal to 18 months; group two, dogs greater than 18 but less than 31 months; and group three, dogs over 30 months. Two time periods were used: "early" for radiographs taken in 1970 to 1974 inclusive and "late" for radiographs taken in 1975 to 1978 inclusive. "Other breeds" in this study consisted of all mixed-breed dogs plus all purebred dogs with less than 20 dogs radiographed (none of the breeds pooled into "other breeds" differed in the rate of CHD from dogs of mixed breeds). "Other breeds" was assigned an odds ratio (relative risk) of one.

The effect of owner on the risk by breed was evaluated for any breed found to have a significantly increased or decreased risk of CHD.

The severity of CHD in the right hip was compared to the severity in the left hip, using a statistic (kappa) for measuring agreement in categorical data (2).

RESULTS

Of 2298 dogs radiographed, 874 dogs (38%) had CHD. The frequency of each grade (severity) occurred in the following order: grade II, III, I and IV (Table I). The observed agreement of grade of CHD in both hips was 0.820 (1810/2242) and the expected agreement was 0.519. The extent of agreement in these grades was significant (kappa = 0.626, se(k) = 0.039 Z = 16.1 p < 0.05). The majority of dogs (68%) were radiographed between 0.5 and 2.5 years of age.

Thirty-five and one-half percent of the 62 dogs of mixed breeds were positive for CHD. The following breeds had a risk of CHD significantly different from mixed breeds (% positive, total number of dogs): afghan hound (10.9%, 46); siberian husky (5.3%, 151); english bulldog (83.3%, 6); great dane (16.1%, 118); kuvasz (71.4%, 14); newfoundland (63.8%, 116); golden

TABLE I
THE FREQUENCY OF DIFFERENT
GRADES OF CANINE HIP DYSPLASIA IN EACH COXOFEMORAL JOINT
DATA FROM O.V.C. 1970-1978

		Grade of Left Hip						Total
		Normal	I	II	III	IV	Not Graded	
Grade of Right Hip	Normal	1422	57	64	20	1	18	1582
	I	40	72	40	10	1	0	163
	II	42	20	150	32	0	0	244
	III	24	11	13	142	9	0	199
	IV	1	0	2	9	24	0	36
Not Graded		16	1	0	1	0	56	74
Total		1545	161	269	214	35	74	2298

The similarity of the grade of dysplasia in left and right coxofemoral joints is assessed with a statistic known as kappa. The significance of kappa is tested using a 'Z' test (2). In this case K = 0.626, Se(k) = 0.039 and Z = 16.1, p < 0.001.

retriever (55.7%, 140); and saint bernard (73.3%, 131).

Of the 73 breeds of dogs in the study, 20 breeds had at least 20 dogs radiographed. There were 1935 dogs in total in this group of dogs. Dogs of these 20 breeds were compared to "other breeds" (30.7% positive) to assess the risk of CHD (Table II) with control of age and time period. The following breeds had no significantly increased or decreased risk of CHD compared to "other breeds": alaskan malamute, bouvier des flandres, irish wolfhound, great pyrenees, miniature poodle, standard poodle, labrador retriever, rottweiler, samoyed, english setter,

irish setter and norwegian elkhound. (afghan hounds had a decreased risk significant at p < 0.10). The odds ratio for breeds having a significantly increased risk relative to other breeds were: german shepherd (1.85), old english sheepdog (1.88), golden retriever (2.75), newfoundland (3.66) and saint bernard (5.14). Great danes and siberian huskies had significantly decreased risks of having CHD relative to "other breeds", with odds ratios of 0.48 and 0.25 respectively.

Five hundred-and-one owners had two or more dogs radiographed; 48 owners had five or more dogs radiographed for CHD. In the latter dogs, it

TABLE II
RATE OF CANINE HIP DYSPLASIA (CHD) FOR BREEDS REPRESENTED BY
TWENTY OR MORE DOGS RADIOGRAPHED AT OVC, 1970-1978

Breed	No. of Dogs	% of CHD	Risk ^a	Significance of Risk ^b
Afghan hound	46	10.9	0.49	NS
Alaskan malamute	66	37.9	1.38	NS
Bouvier des flandres	55	36.4	1.21	NS
German shepherd	402	46.8	1.85	S
Great dane	118	16.1	0.48	S
Great pyrenees	29	20.7	0.76	NS
Irish wolfhound	36	22.2	0.77	NS
Newfoundland	116	63.8	3.66	S
Norwegian elkhound	29	34.5	1.42	NS
Old english sheepdog	119	47.1	1.88	S
Miniature poodle	48	25.0	0.94	NS
Standard poodle	33	30.3	1.10	NS
Golden retriever	140	55.7	2.75	S
Labrador retriever	211	37.4	1.27	NS
Rottweiler	26	30.8	1.10	NS
Saint bernard	131	73.3	5.14	S
Samoyed	64	34.4	1.12	NS
English setter	38	39.5	1.53	NS
Irish setter	77	33.8	1.28	NS
Siberian husky	151	5.3	0.25	S
"Other breeds"	354	30.7	1.00	—

^a Measured by odds ratio. This statistic compares the rate of CHD in each breed to the rate in "other breeds". Odds ratios significantly greater than one imply increased rates. Odds ratios significantly less than one imply decreased rates.

^b The significance of the odds ratio is tested with a chi-square statistic. NS = not significant, S = significant at p < 0.05. (2).

was found that the occurrence of CHD was significantly influenced by owners (kennels) for old english sheepdogs ($\chi^2 = 9.5, p < 0.05$). and golden retrievers ($\chi^2 = 12.5, p < 0.029$). Two owners of old english sheepdogs had greater than, and three owners had less than the average percent positive (47.1%) for CHD. Two owners of golden retrievers had greater than, three owners had less than, and one owner had equal to the average percent positive (55.7%) for CHD in this breed.

There was a significant difference in the risk of occurrence of CHD by sex. Males had a 1.2 times higher risk of CHD than females. ($\chi^2 = 4.7, p < 0.03$).

In the study period, CHD tended to decrease by 1.7% per year when all breeds were considered ($b = -0.017, \chi^2$ slope = 20.0, $p < 0.05$). The occurrence of CHD in german shepherds was found to decrease by 1.95% per year ($b = -0.0195, \chi^2$ slope = 3.99). In old english sheepdogs, the incidence decreased by 4.4% per year since 1970 ($b = 0.044, \chi^2$ slope = 5.36). In saint bernards, the incidence of CHD may have increased by 3.04% per year ($b = 0.0304, \chi^2$ slope = 3.63, $p < 0.10$).

DISCUSSION

We believe our study group represents a more refined sample of the dog population for estimating risk of CHD by breed than that used by some other workers (8, 9). Since CHD essentially is diagnosed only by radiography, non-radiographed dogs are not at risk of (a diagnosis of) CHD.

In the absence of control of age and year as potential confounding variables, five breeds had relatively high rates of CHD: bulldog, kuvasz, newfoundland, golden retriever and saint bernard; while three breeds had relatively low rates of CHD; great dane, afghan hound and siberian husky.

In order to control for possible confounding effects of age and year, stratification into six 2×2 tables (one for each of the three age-group and two year-group combinations) was performed, and therefore only breeds with greater than 20 dogs were used in this aspect of the study. Canine hip dysplasia was found to be most common in the following breeds (ranging from the highest to the lowest risk): saint bernard, newfoundland, golden retriever, old english sheepdog and

german shepherd. Great danes and siberian huskies and probably afghan hounds had a decreased risk. However, in two breeds, old english sheepdogs and golden retrievers, it was found that the increased risk was attributable, at least in part, to the breeder or owner of the dogs.

Previous studies have reported disparate results for the rate of CHD in different breeds of dogs. We believe that some of these differences exist because of the variety of study designs used, rather than actual breed differences in risk of CHD. Priester and Mulvihill (8) used data from all dogs submitted to ten North American veterinary schools from March 1964 to January 1969. They found the relative risk (odds ratio) to be 9.9 in saint bernards, 5.0 in golden retrievers and 4.2 in german shepherds; whereas in the present study the relative risks of these breeds were 5.1, 2.8 and 1.9 respectively, approximately one-half the risk in each case. In contrast to our results Priester and Mulvihill found a significant risk of CHD in labrador retriever (4.3), samoyed (4.0) and english setter (2.4). They report a significant decreased risk of CHD for miniature poodles (0.2); however, this could be more apparent than real, since these dogs are infrequently radiographed for CHD. In our study, 25% of radiographed miniature poodles had CHD.

Henricson, Ljunggren and Olsson (3) used the results from radiographs read at the Royal Veterinary College, Stockholm, from 1959 to 1969. The dogs included all breeds, but the majority were german shepherds and other working breeds, radiographed by practitioners, as part of a program sponsored by the Swedish Kennel Club to control CHD. In general, with the exception of doberman pinschers, the incidence (prevalence) rates reported by Henricson *et al* (3) are close to our results.

Riser and Larsen used the first 36,000 radiographs received by the Orthopedic Foundation for Animals for certification of CHD status (9). These dogs included more than 90 breeds of dogs greater than one year old from both Canada and the U.S.A. but only breeds represented by greater than 100 radiographs were used in their study. These investigators stated that their results might be biased

because obvious cases of CHD, diagnosed by private practitioners, would not be sent in for certification. They found the mean prevalence (\pm SD) of CHD to be $19.2\% \pm 9.43\%$. There is general agreement, at least in relative terms, in the risks by breed with the results of the current study.

Mason cited findings "based on examinations of at least 40 individuals of each breed avoiding excessive representation of any particular blood line" (6). These results do not agree closely with any published study in terms of rate of CHD.

Giant and large breeds have been considered by most investigators (1, 8, 9) to have a higher risk of CHD. For example, risks of 3.6 and 10.2 for large and giant breeds respectively, 20 times and 50 times the risk of small and medium sized dogs have been reported (8). However, since in the present study great pyrenees and irish wolfhounds had no significant risk, and great danes had a significantly decreased risk (0.48) somatotypes *per se* may not play as important a role in the development of CHD as previously thought. Furthermore, a significant proportion of dogs in very small breeds (miniature or toy poodles) may develop CHD.

In contrast to others (8), we found a small but significant difference in the occurrence of CHD by sex, with males having 1.2 times the risk of females. The reason for this difference is unknown, however because of the small odds ratio and the lack of control for age and year effects, the apparent effect of sex may be biased.

The fact that most dogs had CHD diagnosed before two and one-half years is probably due to the practice of certifying dogs free from CHD at approximately 18-24 months of age. Age *per se* was not of interest in this study; rather, age was used as a control variable to prevent it from biasing our estimates of risk. Henricson *et al* (3) found dogs over 24 months of age to have a higher incidence (prevalence) of CHD. This finding was attributed to the onset of clinical signs with age, due to the development of secondary osteoarthritis. The severity of hip dysplasia in our study was very similar in both hips (Table I).

In the current study we found that CHD has been decreasing at an overall

rate of 1.7% per year. However, when individual breeds were considered, the prevalence of CHD remained relatively stable with three exceptions: in german shepherds and old english sheepdogs, the prevalence decreased, and in saint bernards, the prevalence increased. Henricson *et al* (3) found that the severity of CHD (grade II to IV inclusive) had increased in german shepherds in Sweden from 1959 to 1969, despite control programs to decrease the incidence of CHD.

More information is necessary, and more refined studies must be carried out before the true risk of CHD to different breeds can be established. This may necessitate prospective studies on a random sample of dogs of all

breeds. We hope this study will provide some incentive to initiate such work.

REFERENCES

1. BARGAL, U. and R. TRAININ. Prevalence of hip dysplasia in dogs in Israel. *Refuah vet.* 31: 86-89. 1974 (Abstr).
2. FLEISS, J.L. *Statistical Methods for Rates and Proportions.* Toronto: John Wiley and Sons. 1973.
3. HENRICSON, B., G. LJUNGGREN and S.E. OLSSON. Canine hip dysplasia in Sweden: Incidence and genetics. *Acta radiol. suppl.* 319: 175-180. 1972.
4. LEIGHTON, E.A., J.M. LINN, R.L. WILLHAM and M.W. CASTLEBERRY. A genetic study of canine hip dysplasia. *Am J. vet. Res.* 38: 241-244. 1977.
5. LUST, G. and P.W. FARRELL. Hip dysplasia in dogs: the interplay of genotype and environment. *Cornell Vet.* 67: 447-466. 1977.
6. MASON, T.A. A review of recent developments in hip dysplasia. *Aust. vet. J.* 52: 555-560. 1976.
7. NIE, N.H., C.H. HULL, J.G. JENKINS, K. STEINBRENNER and D.H. BENT. *Statistical Package for Social Sciences.* Toronto: McGraw-Hill Inc. 1975.
8. PRIESTER, W.A. and J.J. MULVIHILL. Canine hip dysplasia: Relative risk by sex, size, and breed, and comparative aspects. *J. Am. vet. med. Ass.* 160: 735-739. 1972.
9. RISER, W.H. and J.S. LARSEN. Influence of breed somatotypes on prevalence of hip dysplasia in the dog. *J. Am. vet. med. Ass.* 165: 79-81. 1974.
10. SCARTAZZINI, R. A radiologic study of normal and dysplastic hip joints in six breeds of large dogs. *Acta radiol. suppl.* 319: 183-185. 1972. (Abstr.)

BOOK REVIEW

Prostate Gland and Seminal Vesicles.
Gerhard Aumüller. Published by Springer-Verlag, Berlin, Heidelberg and New York. 1979. Price \$154.00.

This volume is one of the *Handbuch der mikroskopischen Anatomie des Menschen*, a monumental on-going work. These group a fabulous mass of knowledge presented in a very beautiful book. The size of the volume (380 pages) in relation to the very restricted subject indicate the depth or at least the volume of information it contains. It is only by reading, or better, studying the contents that one comes to realize the true quality of the book and to appreciate it fully. The author has succeeded in presenting an astonishing amount of material in an orderly, pre-

cise and very readable manner.

The style is very clear, and permits the book to be packed with up-to-date material without any feeling of heaviness. In other words, this is an extremely condensed review which avoids all frills, thus remaining light and to the point.

A first part deals with the histogenesis and organogenesis, the second part is devoted to the prostate and the third to the seminal vesicles. Any more details as to the table of contents would require pages but it seems that every conceivable aspect of study has been well covered.

Human structures make up the bulk of the material reviewed, but animal variations are dealt with in-depth and with equal elegance. The result is a beautiful work of comparative histol-

ogy, histochemistry and fine structure.

The material presentation of the book is in keeping with the exacting quality of the text. Good quality paper and neat print go together with the clarity and precision of the micrographs and electronmicrographs. Many of the micrographs are in colour. The few diagrams presented are very helpful in visualizing the concepts put forward in the text. The binding is distinctively sober and elegant.

The only drawback to this book, and it is quite serious, is the rather outlandish price. This will limit greatly the diffusion of this masterly piece of technic, style and scholarly achievement. Otherwise, this type of book belongs to the libraries of any self respecting medical, veterinary or research institution. *C. Gardell.*