Canine Hip Dysplasia:

Are Breeders Winning the Battle?

Including Comprehensive Sections On Methods for Diagnosing and Predicting Genetic Predisposition

Canine hip dysplasia (CHD), a disease resulting from a predisposition to increased muscle laxity involving the hip joint (see Bone Disorders), poses a major concern to dog breeders. Over the past several decades, dog breeders have come to rely on the diagnostic methods of the Orthopedic Foundation for Animals (OFA) and their rating system to screen breeding stock and breed only those individuals devoid of CHD in order to reduce incidence of CHD in future offspring. Despite these attempts and the OFA's encouraging reports of a significant decline in occurrence of breed-specific CHD, there still remains a very high prevalence of CHD not accounted for by the OFA. Additionally, frequency of CHD in offspring from OFA normal parents still remains disappointingly high.

Over the past 5 years, some revealing scientific reports have raised serious questions concerning the reliability of the OFA method for evaluating phenotypic expression (actual appearance of hip conformation) of parents as a means of predicting genetic outcome in offspring as well as the consistency with which these evaluations are interpreted.

The following takes a closer look at current diagnostic methods for evaluating hip-joint conformation and their reliability for predicting predisposition to CHD. Additionally, it presents an overview of several studies performed which suggest that the OFA method for breeding stock, though currently the most popular

choice, may not be the best method for minimizing CHD in future generations.

Are breeders winning the battle against Canine Hip Dysplasia (CHD)?

In a 1992 report on the incidence of CHD in purebred dogs, the OFA reported a 79% decrease in the occurrence of CHD when comparing dogs bred between 1972-1980 with dogs bred between 1981-1988. Though upon first glance, this data suggests a significant advance in the control of CHD, it was recognized that some variables had not been controlled for in the study. For example, this data would only be relevant if all hip radiographs (X-rays) were sent to the OFA for review. However, a review of records at the Veterinary Hospital of the University of Pennsylvannia (VHUP) indicated that only half of clients having their dogs x-rayed for the purpose of acquiring OFA certification actually ended up submitting the radiographs to the OFA for review. It was determined that clients only submitted radiographs of dogs having the greatest likelihood of being certified. In comparison to the OFA's reports for breed-specific incidence of CHD, a clinical survey conducted at VHUP demonstrated breed-specific incidence of CHD to be 2-3 times higher than reported by the OFA.

What are the current methods for diagnosis of Canine Hip Dysplasia (CHD)?

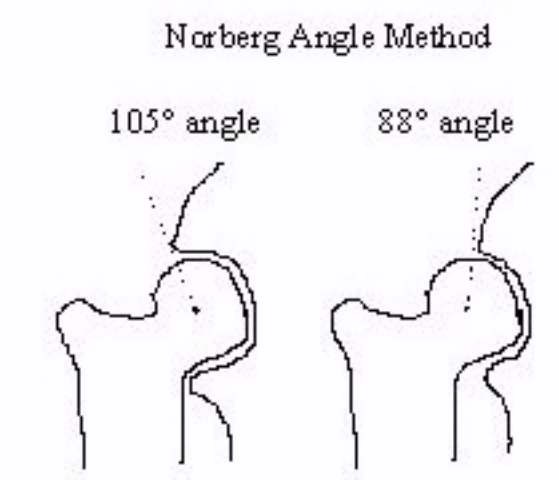
There are 3 methods for diagnosis and prediction of predisposition to CHD in dogs which can be divided into 2 groups:

1) hip extension radiograph methods and
2) the stress radiographic diagnostic method.

These groups are categorized based on the positioning of the dog while the radiograph is taken. The first group is the most common method in which the dog, while lying on its back, has its rear legs fully extended with the knees rotated inward. The second group requires that the dog be anesthetized and while lying on its back, the dog has its legs positioned as they would be if the dog were standing. A custom-designed device is placed between the legs which forces them apart, thereby displacing the ball of the femur from the hip socket and allowing for observation of joint laxity.

The first group can then be divided into 2 methods:

The Norberg Angle method



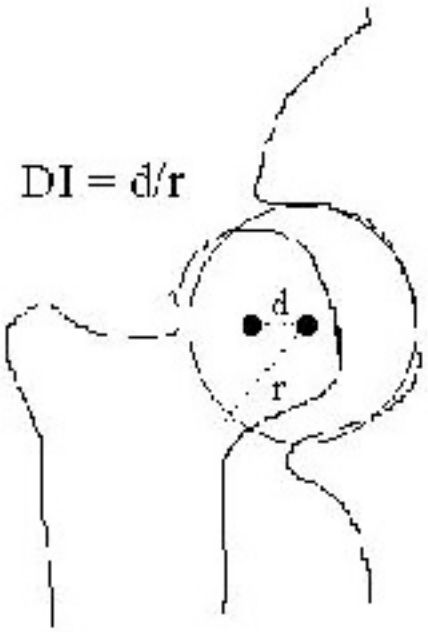
This method is a quantitative method because it is based on measurement of the angle formed by connecting a point at the center of the femoral head (ball of the hip) to the upper acetabular rim (hip socket). Hips are then scored as the number of degrees in the formed angle. For example, scores range between 55 to 115 degrees with low end scores indicative of greater hip laxity and higher risk for CHD. Dogs receiving scores above 105 degrees are accepted as having normal hip-joint conformation with lower predisposition to CHD.

The OFA method

This method is a qualitative method because no form of measurement is utilized. Instead this method is based on subjective visual criteria such as degree of joint laxity (subluxation) and the presence of degenerative joint disease.

The second group has one method:

The Distraction method (or PennHIP method)



Distraction Method

This is a quantitative method like the Norberg angle. However, this method measures the separation distance of the femoral head center (ball of hip) from the acetabular center (socket) while

the hip joint is forced to luxate, then divides this measurement by the radius of the femoral head (ball of hip). In effect, this method evaluates how far the femoral head can be displaced from the acetabulum. The resulting number is termed the distraction index (DI). The DI score can range from 0 to 1 with scores closer to 0 indicating less hip laxity. Dogs receiving a score of less than 0.3 are considered to have normal hip-joint conformation with little, if no risk for CHD.

How do the results of these three methods compare to one another for evaluation of hip joint conformation?

1) hip extension radiograph methods vs. the stress radiographic diagnostic method for evaluating hip-joint laxity

In 1993, Heyman et al. reported that the conventional hip extension method for evaluating laxity of hips produced at least a 50% reduction in observable hip laxity compared to the stress radiographic method. This suggests that dogs evaluated based on the hip extension method may have a greater degree of hip-joint subluxation than appears.

2) Norberg angle vs. OFA

In a study conducted at the Veterinary Hospital at the University of Pennsylvannia (VHUP) comparing OFA ratings to Norberg angle measurements it was determined that the average Norberg angle score for dogs judged to have "normal" hips by the OFA was 104 degrees and those judged to have "dysplatic" hips was 96

degrees. Of those dogs judged to have normal hips, 46% had Norberg angle scores lower than 105 degrees (the Norberg cut-off for normal) and even dogs with a Norberg rating as low as 89 degrees had been evaluated as "normal" by the OFA. This suggests that dogs which would be judged predisposed to CHD by the Norberg angle method are being certified for breeding by the OFA method.

3) Distraction index vs. OFA

A study conducted by Smith et al. comparing DI scores to the OFA rating system found that dogs judged to have mild, moderate or severe CHD by the OFA method also had DI scores above 0.3 with a mean DI score of 0.55, therefore a high incidence of agreement exists between these two methods in relation to the dysplastic phenotype. However, when dogs which had been judged by the OFA method as having "excellent" hips were evaluated for DI scores, 50% of these dogs had DI scores of greater than 0.3. Of those judged as having "good" hips, 66% had DI scores greater than 0.3, and in the "fair" hip group, 100% had DI scores greater than 0.3. In this study, 71% of the dogs certified for breeding by the OFA method had increased hip laxity which would predispose them to CHD according to the DI method.

Why is there so much disparity between the Norberg angle and DI scoring methods in comparison to the OFA method?

1) Each method tells a different story

The most likely answer to this question is that although all of the methods are used for the diagnosis of CHD, they are addressing the issue differently. For example, the OFA bases its evaluation on the appearance of an individual dog's hip-joint conformation at a particular point in time, therefore, in the absence of

degenerative joint changes the individual dog will be certified by the OFA. As such, the OFA method is limited as an indicator of phenotype, the actual appearance of the hip-joint of that individual dog, which will not necessarily be any indication of influence on future offspring. However, the Norberg angle method and the DI score, by quantitating hip laxity which is believed to be the prime cause of CHD, are more indicative of genotype. That is to say, for the same dog certified by the OFA method to be free of CHD, a notable increase in hip-joint laxity demonstrated by quantitative methods may identify the dog as a genetic carrier for CHD. There are several additional factors which may account for the alarming disparity found to exist between these different methods for diagnosing and predicting predisposition to CHD:

2) Environmental factors play a role in phenotypic expression of CHD

Although the exact cause for CHD is still unknown, genetic causes for CHD are believed to be polygenic, that is, CHD is believed to be attributed to many genes. As such, polygenic traits are often influenced by environmental factors. For example, in studies conducted with Labrador Retrievers and German Shepherd Dogs it was found that restricting calories and limiting food consumption resulted in lower incidence of CHD compared to dogs who were fed high-calorie diets or were allowed to eat as often as they chose. Even in groups of dogs genetically predisposed to CHD (offspring of CHD afflicted parents), restrictive diets yielded a lower incidence of CHD. Because many breeders and dog enthusiasts are aware of the environmental variables which may influence phenotypic expression of hip-joint conformation, they may take measures to reduce risks for CHD within their own dogs. For example, breeders may reduce risks of CHD in their dogs by feeding a maintenance diet to discourage rapid growth in puppies. Other breeders may restrict a growing dog's activity to moderate levels in order to reduce strain on developing joints and connective tissue. These methods may help

to reduce or eliminate early detectable evidence of CHD brought on by increased hip laxity in the individual dog. As a result, such preventative measures may allow the dog to acquire OFA certification, yet the same dog would still exhibit hyperlaxity of the hip-joint making it a poor candidate for breeding.

3) Other external factors influencing hip ratings...What day of the week the x-rays are reviewed?!?!

Subjective methods of evaluation can lead to unintentional bias and inconsistency for reproducibility of results. A study conducted at the University of Pennsylvannia revealed a startling amount of variability for hip interpretations among non-OFA and OFA board certified radiologists. When these radiologists were asked to grade hips based on the OFA rating system (excellent, good, fair, borderline CHD, mild CHD, moderate CHD or severe CHD), non-OFA readers agreed with an OFA reader in fewer than 50% of the cases. The most disturbing revelation was that when each radiologist was asked to rate certain cases a second time, each radiologist gave the same rating that he had given the first time on less than half the radiographs.

If the OFA method is not the best method for lowering incidence of CHD, why are breeders still using it?

Like the Norberg angle method which has stringent requirements for achieving a "passable" score, the DI scoring system has not become a popular screening method among breeders. This may be because breeders are looking at these diagnostic methods as "pass/fail". Many breeds, particularly medium and large breeds, have mean DI scores ranging between 0.40 to 0.74. If one were to use a 0.3 DI cutoff, no individuals within these breeds would be considered acceptable breeding stock. Therefore, using the DI score as a pass/fail criteria is not a suitable alternative. Rather

than using the DI scoring method to choose whether or not to breed an individual dog, perhaps a better suggestion is to use the method to progressively select for lower hip laxity in future generations. For example, if a bitch achieves an OFA normal rating and a DI score of 0.52, it would be better to breed her to an OFA certified stud with an equal or lower DI score. Additionally, because the DI method can be performed as early as 16 weeks of age with indicative results, breeders can use the DI scores as another criteria for choosing puppies for future breeding stock.

How does the Labrador Retriever breed, on the average, fair in terms of susceptibility to CHD?

As of 1995, the medical data base at PennHIP had recorded DI evaluations of approximately 1500 Labrador Retrievers. The mean DI score for the breed was 0.45, suggesting that the breed, in general, has a tendency for increased hip laxity and, therefore, a higher predisposition to CHD compared to breeds with mean DI scores of less than 0.3.

In 1993, a study of joint laxity and its association with hip dysplasia in Labrador Retrievers was conducted at Cornell University. In this study, the investigators examined early (at 4-8 months) DI scores of Labrador puppies produced by parents with normal hips to those produced by parents with dysplastic hips. Mean DI scores of the former group were significantly lower (0.39) compared to DI scores of puppies produced by dysplastic parents (0.54). Additionally, DI scores of less than 0.4 evaluated as early as 4 months of age predicted normal hips in 88% of the dogs, while DI scores of greater or equal to 0.4 predicted CHD in 57%. When DI scores were applied on an individual basis to predict the occurrence of clinical CHD, dogs with DI scores above 0.7 had a high probability of developing CHD at a later age while those with DI scores of less than 0.4 had a high probability for not

developing CHD. However, DI scores between 0.4 and 0.7 were less reliable for prediction of clinical CHD in Labradors.

Recent Medical Publications on Canine Hip Dysplasia with Reference to PennHIP:

Adams WM, Dueland RT, Daniels R, Fialkowski JP, Nordheim EV. Comparison of two palpation, four radiographic and three ultrasound methods for early detection of mild to moderate canine hip dysplasia. Vet Radiol Ultrasound 2000 Nov;41(6):484-90

Puerto DA, Smith GK, Gregor TP, LaFond E, Conzemius MG, Cabell LW, McKelvie PJ. Relationships between results of the Ortolani method of hip joint palpation and distraction index, Norberg angle, and hip score in dogs. J Am Vet Med Assoc 1999 Feb 15;214(4):497-501

Todhunter RJ, Acland GM, Olivier M, Williams AJ, Vernier-Singer M, Burton-Wurster N, Farese JP, Grohn YT, Gilbert RO, Dykes NL, Lust G. An outcrossed canine pedigree for linkage analysis of hip dysplasia. J Hered 1999 Jan-Feb;90(1):83-92

Adams WM, Dueland RT, Meinen J, O'Brien RT, Giuliano E, Nordheim EV. Early detection of canine hip dysplasia: comparison of two palpation and five radiographic methods. J Am Anim Hosp Assoc 1998 Jul-Aug;34(4):339-47

Smith GK, LaFond E, Gregor TP, Lawler DF, Nie RC. Within- and between-examiner repeatability of distraction indices of the hip joints in dogs. Am J Vet Res 1997 Oct;58(10):1076-7