

Comparing PennHIP and OFA

Many of us with a passion for working and sporting dogs are all too familiar with Canine Hip Dysplasia, one of the most prevalent polygenic diseases affecting many of our preferred breeds. Today, there are a variety of methods that may help us to test for and diagnose the presence or probability of CHD and degenerative joint disease. Following are two articles reviewing PennHIP and OFA radiologic protocols for evaluating and predicting CHD. Fred Lanting, canine consultant and author, responds to some email list posts with his commentary promoting the PennHIP extraction method, and recommends its use over OFA protocol to screen for CHD. Drs. Keller and Corley, Diplomates of A.V.C.R. and principal radiologists of the Orthopedic Foundation for Animals (OFA), detail the research studies and scientific literature that support their position that PennHIP stress radiography remains to date an inconclusive method for reliable testing and evaluation. - Moc Klinkam

PennHIP: Misconceptions and Misinformation

By Fred Lanting

Breeders have a very interesting tool these days in the Internet and/or e-mail. Information gets out much faster than print media can disseminate it. Among the accepted characteristics of such transmission are slightly higher "I.Q." (inaccuracy quotients) and emotion levels. It seems that these minor failings are forgiven in the informal tone of this medium. However, it still behooves anyone doing the work of a journalist, commentator, or editor to be as accurate as possible, for people tend to believe anything they see "in print". Recently, there have been lively discussions on at least one list or website, excerpts of which have been circulated to others. These deal with the latest development in diagnostic-predictive techniques, and unfortunately fanciers have taken sides based on less than complete information. Understandable; I found in 35 years in chemical marketing that people make decisions based not so much on logic or reasoning, as much as on emotional leanings.

Here are some recent website quotes I've been given, and my responses. I encourage you readers to make yourselves available to one of my lectures. Better yet, to schedule one. "Have slides, will travel". E-mail me at mrgsd@hiwaay.net for details. First, the quotes and misinformation, then my answers.

Quote 1.: "(Some people) bought a dog and it turned out to be dysplastic at 2 years, when her (OFA) prelim at 10 months looked excellent. This may be an argument for using PennHIP, said to be more predictive. In the PennHIP X-rays, more laxity can be measured." This lister tries to be cautious yet seems to lean toward confidence in the newer (a decade now) method of screening dysplasia at younger ages.

Quote 2.: "... a bummer when that happens. However, studies have not shown PennHIP to be more reliable in predicting HD than OFA. In fact they show the opposite (JAVMA volume 21 #9 Nov 1, 1997); in referring to OFA: 'The study showed that a preliminary evaluation of Excellent was 100% reliable; a preliminary evaluation of Good was 97.9% reliable; a preliminary evaluation of Fair was 76.9% reliable...'. Also, (Am J Vet Res 1993; 54: pp.1021 - 1042) in referring to PennHIP: '12% of the dogs evaluated as normal at 4 months of age by the PennHIP method were later determined to have degenerative joint disease. 48% of the dogs evaluated as abnormal at 4 months of age, 57% evaluated as abnormal at 6 months of age and 38% evaluated as abnormal at 12 months of age by the PennHIP method did not have evidence of degenerative joint disease at 24 months of

age'. A second study on the PennHIP method (Am J Vet Res; 1993; 54: pp.1990-1999) concludes that while a distraction index less than 0.4 is 88% reliable for predicting normal hips, a distraction index of greater than 0.4 is only 57% reliable for predicting CHD. While no method would be 100% reliable, it would appear that the OFA method is more reliable at early prediction of CHD. What bothers me most about the PennHIP method is the very high percentage (38 - 57%) of those dogs evaluated early where they predict CHD will develop, but it doesn't. Thus, if you use the PennHIP method for early evaluation, you have a very good chance of eliminating a non-dysplastic dog from your breeding program due to less than accurate results."

My Response

By the way, while the veterinary community largely uses the abbreviation CHD for Canine Hip Dysplasia, I use the lay practice of referring to it as HD, since the context is always clear that we are talking about the disease in dogs, not in humans or other animals. Now, as to the quote #2 above: far from concluding that OFA is more reliable and accurate, the cited journal references, which I have on the desk before me, can only logically lead to the realization that the opposite is true, except for the Nov. 1st, 1997 reference written by Al Corley and Greg Keller of the OFA. To be fair, one must also read at the same sitting, the letter to the editor on page 487 in JAVMA's vol. 212, #4, Feb. 15, 1998 which effectively refutes those OFA conclusions. OFA statistics are skewed because not all films are sent in; PennHIP requires ALL films, whether showing horrible hips or not, be sent in and entered into the database. The OFA article did not let readers know that apples were being compared to oranges --- that the presumably higher rate of false positives PennHIP reports is a result of different definitions. OFA says a dog is dysplastic if it has loose hip joints, signs of arthritic changes or wear, or both. PennHIP diagnoses frank HD on the basis of DJD (degenerative joint disease... bony changes and remodeling). If they had included the lax-hip dogs not showing such changes, the false-positive rates would be much lower. The PennHIP evaluation not only reports as dysplastic those with obvious bone and cartilage abnormalities, but also gives an idea of the relative risk of the particular dog developing such radiographic signs later. The dog whose hip joint's femoral head looks tight and round on the OFA film but shows considerable laxity on the PennHIP view is said by the latter group to be at risk for later DJD. Which information would you want to have?

Remember, the traditional position advocated by AVMA and OFA (as well as almost all other hip schemes of the past 35 years) is the leg-extended (hip-extended) one in which the ligaments of the hip joint capsule are wound tight like the rubber band in those toy airplanes we old fogies used to play with as kids. This tends to present an artificially tight appearance to all but the worst hips, and is certainly not representative of the forces at work in the standing or walking/trotting dog. The PennHIP scheme utilizes this hip-extended view in order to best see some features that might show DJD; by the way, if you want an OFA reading, the vet need only put two films into the cassette when taking this picture. The view with the dog's legs flexed in a position like standing, but upside-down, mimics actual forces. And when the hip joints are stressed in the distraction view (femurs and femoral heads pushed away from each other and the acetabulums) and then the difference in displacement measured from the picture given when they are pressed into the sockets, why then you have a numerical, objective value: something you can use to compare with others of the same breed, for example.

Now, let's look at the predictive value of OFA's preliminary evaluations, and I won't go at length into why suddenly these are supposed to be so accurate, when in 1972 OFA led the way to a 24-month minimum for certification because of the inaccuracy of early diagnoses. Let's assume that only the very worst hips will show bony changes, and that the youngsters now being "prelim'ed" are judged primarily on laxity. The OFA is happy to predict, on the basis of very tight joints IN THE HIP-EXTENDED VIEW at a young age, that such an excellent appearance will continue to look good at 2 years (minimum age at which to certify). But remember, the view at 2 years is going to be the same type, that of an artificially wound-up joint capsule. Surely, then, one would expect fairly good agreement between the pictures at these two ages, especially if rated "Excellent" in the AVMA position. However, if one applies the more stringent evaluation protocols of the PennHIP method at the older age, one finds a disturbing number of "OFA-normals" are indeed not normal in any sense that you and I would consider so, such as compared with the mean or average in the breed. Even an unacceptably high number of OFA-Excellents at 2 years will show up in the PennHIP view to have worse hips than would otherwise be suspected. If you want to know if a bridge can bear a load of 10 tons, you shouldn't expect to run a meaningful test by driving your half-ton pickup over it. The dog also should be evaluated in the strictest method in order to tell if the reading of "excellent" has any validity. Otherwise, the breeder or the person driving a big truck over a bridge may have a false sense of security.

Those who look into professional journal articles should perhaps ask, "Where are the data showing a link between OFA-defined laxity and later DJD?" and "Where are the data on dogs diagnosed as dysplastic (based on laxity at 24 months) but who never developed the bony changes?" Since there is no such set of statistics, one must conclude that hip-extended radiographic diagnosis (alone), even at 24 months, is not "reliable" as the OFA's JAVMA article proposes, but highly unreliable, or at best, unknown. Are you as a breeder satisfied with repeatability (unfortunately described as reliability)? Suppose you were William Tell's son, and you knew that your dad could shoot a dozen arrows at the apple balanced on your head, with repeatability as to where each would go --- would you be blithely unaffected by the concept that his reliability (accuracy) might not be as good as his repeatability? You would not want even the first arrow to fly, would you? Diagnosing HD is not as threatening as that, but I for one would want the most accurate as well as the most reliably repeatable evaluations of my breeding stock's hips.

DJD appears in some individual dogs and in some breeds at later ages than in others. The breeder wants to know as early as possible, what the likelihood is that his dogs might develop DJD, and therefore wants some sort of "marker" or predictive evaluation before he sells or breeds. The panacea of gene markers (looking at DNA and finding all the sequences that cause HD) is not practical in our lifetimes (or at least not in our current dogs' lifetimes). If anybody even were to come up with cheap testing of such polygenic traits, this approach is still decades away. The OFA study reported in that JAVMA article did not include in its references any longitudinal studies to refer the reader to, even though a year or so earlier such a report by Banfield, Bartels, Hudson, et al showed almost no difference in dogs predicted to develop degenerative changes and those described as having normal hips, using the OFA-style methods. The 40 dogs described as "normal" at 2 years of age all had some "minimal or mild degenerative changes" by 9 years of age, and those 22 dogs diagnosed as dysplastic (lax joints in the hip-extended

view) at 2 years had the same mild or minimal changes. Why wasn't this study included? Does it give you a warm feeling that you are using the latest and most accurate diagnostic techniques by banking on the OFA readings?

We shouldn't worry so much about false positives (a red flag that a dog might become dysplastic, but doesn't) as we should about false negatives (the dog is evaluated as normal, and later proves to be chock-full of "bad genes" that his offspring inherit). We would rather cull from the breed an occasional good dog (there are many ready to take his place) than let some covert fifth-columnist into the ranks to poison or sabotage the gene pool. In the OFA system there are false-negative rates of about 83% in 6-month-old German Shepherds, but in the PennHIP scheme, the rate is only 12% in 4-month-old dogs and 0% at 6 months (as compared to the readings at 24 months). The writer who complains about this 12% fails to acknowledge that using the OFA approach on 4-month pups gave a false-negative rate of 24%, double that of the PennHIP compression-distraction method. Even at 6 and 12 months, the OFA-type predictive tests gave false-negatives of 15% and 12% and the PennHIP stress-radiographic method showed zero false negatives for 6- and 12-month old dogs.

To rest one's case on the above-mentioned "48% of the dogs evaluated as abnormal at 4 months of age, 57% evaluated as abnormal at 6 months of age and 38% evaluated as abnormal at 12 months of age by the PennHIP method" as not having "evidence of degenerative joint disease" is to rest on the false positives. What of those dogs that did not have DJD at 2 years of age, but more laxity than the average in their breed? Are you satisfied that they have as few bad genes as do the dogs that were identified early as having a very low DI (distraction index) and still do not have DJD in old age? The PennHIP method is a far better revealer of genotype, and thus predictor of eventual DJD, in the individual and its progeny.

It should not be surprising to anyone that the looser the hips, the less accurate that a prediction of a specific grade or severity might be. HD is a developmental (DJD might not show up right away), progressive (it'll eventually be worse), multifactorial (environment has a part to play in the expression of the bad genes) disorder. Some dogs will get worse than others even with the same DI at a young age. A DI of 0.4 is not all that bad, nor all that good. You can pretty much guarantee your buyers that the pup you sell them with a 0.3 will never have DJD (HD), but you lose credibility with such a guarantee as that index creeps higher and higher. You can think of an index of 0.4 as being "40% out of the socket" if you want to oversimplify the picture, since the readings runs from a hypothetical 0 (zero would mean no ability to move in the socket) to a full luxation of 100% out of the socket, or DI of 1.0 (and of course in the worst cases, the number can be over one, but those dogs will have bad bone changes, too, so it doesn't take a rocket scientist to see they are dysplastic). In many breeds, the mean or average laxity is around 0.4 and it is worse in many other breeds. Some breeds can tolerate looser hips than a GSD and have less development of arthritic degeneration in maturity. The person who worried about the "38 - 57% of those dogs evaluated early where they predict CHD will develop, but doesn't..." isn't adding "at two years of age", and again ignores the much worse situation where at least an equally high percentage of OFA-normal dogs might develop late-onset DJD and/or pass on many bad genes to offspring. There is very good reason to presume that dogs that have no signs of DJD but have an index higher than the mean for their breed "represent a carrier state of the disease", as mentioned in the

second Am J Vet Res citation above. In other words, it is a clearer picture of the genotype than the OFA approach gives. Man has advanced over his prehistoric precedents by using more tools, and we should progress in use of modern tools regarding HD as we have from the Neandertal to the Stone Age to the Bronze Age to the Machine Age, and to the Computer Age. PennHIP is such an advanced tool for the serious breeder. The inescapable conclusions are that:

Tighter Is better;

Position and technique (better tools) can discover covert laxity;

PennHIP is more accurate as well as reliable and repeatable.

Most of the people on these Internet chat rooms and e-mail lists are not "professional people" by which in this context is meant trained veterinarians. Thus, it is natural that few would realize until pointed out to them, that there are significant differences between types of articles they read. Something that appears in a medical journal such as JAVMA are closely examined in a process called "peer review" before being edited and published. Both accuracy and logical reasoning are required, in addition to sound references and proper controls and procedures in the reported experimental work. On the other hand, articles that appear in newsletters, flyers, press or publicity releases, brochures, and the like, are not subject to such hurdles and requirements. The OFA press release that was carried by a number of breed magazines such as the Australian Cattle Dog publication in mid-1998 was a rather strongly biased advertisement for OFA business --- absolutely nothing wrong with that approach, by the way. The AVMA Journal version published Nov. 1, 1997 was what remained after the review process removed all the unsubstantiated claims. Now, such claims may be valid; it's just that in this case, they were not subjected to protocols regarding scientific method and therefore the "commercial version" may have been misinterpreted by some as having the weight of the reviewed version.

The optimist in me sees the day when OFA leadership will have to admit the superiority of new tools, adopt the PennHIP approach, and report such data for the benefit of the breeder. The pessimist in me wonders if the parties can put personalities aside and concentrate on science, and if I'll live long enough to see this happen.

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Copyright 1998 by Fred Lanting. For reprint rights, contact the author. OFA Update: The Issue of Joint Laxity and Stress Radiography

By G.G. Keller, D.V.M., MS, Diplomate of A.V.C.R., Executive Director Orthopedic Foundation for Animals, Inc. and E.A. Corley, D.V.M., Ph.D., Diplomate of A.V.C.R.

OFA does not normally respond to the various opinions expressed by individuals on Internet web sites and/or chat lines. Instead OFA maintains a web site (<http://www.offa.org>) to provide information that may be of value to breeders and veterinarians. However, a response to the opinions expressed by many people is prompted, as the opinions appear to have deteriorated to the point of becoming non-productive. OFA stated its position on any testing method, including PennHIP, that involved stress radiography to the breed clubs in 1994. This posting is a review of that position.

Contrary to some Internet postings, OFA, a not-for-profit organization, does support and encourage research on joint laxity and its meaning. The fact that joint laxity plays a role, but is not the only factor to be considered in development of hip dysplasia and its

secondary changes of degenerative joint disease, has been recognized for over 30 years. This fact is not in dispute. The issue has been, and remains to be, the relationship of laxity that is demonstrated by forcing the heads of the femurs away from the acetabula by palpation or a fulcrum/stress device (i.e., a distraction device) to abnormal laxity (functional laxity that occurs in hip dysplasia.) Since 1972, when an independent panel of scientists classified the techniques for demonstration of joint laxity by use of an externally applied force as experimental, OFA has financially supported three research projects, recommended by external review, to answer the basic question. Dr. Belkoff, et.al. (VCOT 1: 31-36 1989) developed a device that measured the amount of force applied to the hips and noted that some dogs that demonstrated abnormal amounts of laxity were free of hip dysplasia at necropsy. These authors questioned the meaning of joint laxity as demonstrated by force. The other two projects supported by OFA are ongoing.

PennHIP is another technique for demonstration of forced (passive) laxity that is also attempting to answer the basic question of the relationship of passive laxity to functional laxity. OFA encourages their research efforts; however, OFA takes exception to the marketing techniques and claims used to promote the PennHIP testing method for clinical use, as the use of this method appears to be premature. In other words, commercialization (marketing) of the method has outreached the science.

OFA feels that general use of PennHIP as a mass screening test method for hip dysplasia is premature because:

The primary basis for marketing PennHIP was reported by Dr. Smith, et.al. (Am J Vet Res, July 1993) using a modification of a previously described positioning, stress/fulcrum technique. The study was a survey type involving 142 dogs (105 of which were German Shepherd Dogs). The results of the study were questioned by Dr. Susan Shott of the Biostatistical Unit, Rusk Cancer Institute (Am J Vet Res, December 1993) who challenged the analysis of the data and stated: "The data does not support the author's conclusion that the DI was the most important and reliable phenotypic factor for determining susceptibility of hips to degenerative joint disease ... and that this determination could be made with an acceptable degree of accuracy as early as 4 months of age."

Dr. Lust, et.al. (Dr. Smith was a coauthor) in a report involving 42 Labrador Retrievers (Am J Vet Res, December 1993) concluded that a DI of <0.4 at 4 months of age correctly predicted normal hips in 88% of the cases and a DI of >0.4 correctly predicted hip dysplasia in 57% of the cases. The authors further concluded that: "Distraction indices between 0.4 and 0.7 and at either 4 or 8 months of age were not associated strongly enough with evidence of disease to be clinically reliable in predicting, on an individual basis, the outcome for dysplastic hip conformation when the dogs were older."

No breeding data based on PennHIP has been reported. Dr. E.A. Leighton (JAVMA, May 13, 1997) reported on genetic progress in improving the hip quality in German Shepherd Dogs and Labrador Retrievers in the Seeing Eye closed colony of dogs. In less than 5 generations the percentage of hip dysplasia was decreased from 55 to 24% in the German Shepherd Dogs and from 30 to 10% in the Labrador Retrievers using the hip extended position and a modified OFA evaluation procedure. PennHIP DI measurements were also made but the mean DI across generations did not change. It should be pointed out that DI

was considered experimental and breeding selection criteria did not include the DI. It will be interesting to see the results when DI is included as a selection criterion.

With the above reservations, plus experience with the issue of joint laxity, OFA would be remiss in its responsibility to either endorse or reject the PennHIP testing method. In other words, the jury is still out! This leaves the breeder in a dilemma as to which testing method to use, OFA or PennHIP or both, as they are entirely different test methods for the same disease.

There is a great economic advantage to breeders for determination of the hip status at a young age and to assess the risk for development of hip dysplasia at a later age. OFA reported (Vet Clinics of No Am, May 1992) on a study of 3,369 dogs from 25 breeds. Reliability of the preliminary evaluations ranged from 71.4% in the Chesapeake Bay Retriever to 100% in the Welsh Springer Spaniel. The preliminary evaluation appeared to be breed dependent and dependent on the evaluator's experience with the skeletal development of that breed at the age of evaluation.

When faced with the problem of comparing entirely different test methods for determining dysplasia, scientists evaluate the results of reported values for false negative (probability of diagnosing a dysplastic dog as normal), false positive (probability of diagnosing a normal dog as dysplastic), specificity (probability of a normal dog receiving a normal evaluation), and sensitivity (probability of a dysplastic dog receiving a dysplastic evaluation). These values for OFA preliminary evaluations by age and hip ratings, in a different population of dogs than previously reported (Vet Clinics of No Am., May 1992) have been reported (JAVMA, November 1, 1997). The false negative and false positive values for PennHIP were reported by Dr. Smith et.al. (Am J Vet Res, July 1993). No report of selectivity or sensitivity values for PennHIP were given. There were 2,332 dogs in this OFA study and 142 dogs in the PennHIP study. The limited number of dogs resulted in a larger confidence interval for the PennHIP values.

Confidence intervals (CI) are determined so that one can be 95% confident that the true value lies within the calculated range. The false negative values for OFA evaluations were 8.9% (CI=5.9 to 12.9%) at 3-6 months, 6.0% (CI=4.4 to 8.0%) at 7-12 months and 3.8% (CI=2.6 to 5.4%) at 13-18 months of age. The false negative values for PennHIP evaluations were 12% (CI=1.5 to 38.3%) at 4 months and 0% (CI=0.0 to 15.4%) at 12 months of age. It appears that the probability of retaining a dysplastic dog in the breeding pool is the same for either test method.

However, the false positive values for PennHIP were significantly greater (48% at 4 months, 57% at 6 months and 38% at 12 months) than those for OFA evaluations 17.6% at 3-6 months (CI 10.8 to 26.4%), 10.0% at 7-12 months (CI 5.7 to 15.9%) and 8.5% at 13-18 months (CI 4.8 to 13.6%). It appears that the probability for removing a normal dog from the breeding pool is less with the OFA evaluations.

Dr. Adams, et.al. (JAAHA, 1998, 34: 339-47) reported (using palpation, OFA method, PennHIP, and Norberg angle measurements) on results of a study of hip laxity, in 32 dogs from 4 breeds (12 Greyhounds, 4 Labrador Retrievers, 12 Irish Setters, and 4 hound-mix) at 6-10 weeks and 16 to 18 weeks that were compared to detection of degenerative joint disease at 52 weeks of age. Five hips with evidence of subluxation but no evidence of degenerative joint disease on the OFA type evaluation of the hip extended view were eliminated from analysis. The authors concluded that DI and Norberg Angle measurements at 6-10 and 16-18 weeks were the most reliable predictors of hip dysplasia,

at 52 weeks of age, with DI being more reliable than Norberg. The OFA and palpation methods at 6-10 or 16-18 weeks were not reliable predictors. This is not surprising as reliability of OFA preliminary evaluations has been shown to increase with age of evaluation. The OFA report (JAVMA, Nov. 1997) included 380 dogs evaluated at 3 to 6 months of age. The reliability was 89.6% (CI=85.4 to 92.9%) for normal evaluations and 80.4% (CI=71.4 to 87.6%) for dysplastic evaluations. The mean age was 4.8 months (19.2 weeks) and the median age was 5 months (20 weeks) which means that over half of the dogs in the OFA study were older than in the study reported by Dr. Adams. OFA data and PennHIP data are not representative of the general population of dogs because the programs are voluntary, most dogs are in pet homes and are not radiographed, and not all radiographs of dogs radiographed are submitted for evaluation by either program. For example; if an attending veterinarian determines a dog to be dysplastic, by either method, the radiograph(s) may not be submitted to save the owner money. PennHIP collaborators may take the hip extended view first and if the radiograph shows evidence of dysplasia the DI views may not be taken or the owner may not allow submission of an obviously large DI measurement.

Breeders are aware of the economic value of early screening of dogs for determination of the hip status. They should also be aware that both OFA and PennHIP use the radiographic evaluation of the same hip extended projection as the standard for comparing with the results of the early evaluations. The OFA standard represents the consensus of 3 independent evaluations at >24 months of age by board certified veterinary radiologists. It is not clear who evaluates a radiograph submitted for PennHIP determination, but the original study reported the standard to be Dr. Smith's evaluation. This evaluation at >24 months of age has approximately 5% false negative finding as reported by Dr. Jessen (Proceedings of a 1972 symposium on hip dysplasia) and by an internal OFA study of dogs evaluated at 24 months that were re-evaluated at an older age. This is why OFA requires the 24 month certification age. Voluntary submissions to PennHIP will provide information on the range, mean and median of the DI measurements for the various breeds. The meaning of the measurements remains unclear and will require repeat studies, on the same dogs, at >24 months of age.

Breeders must be aware of the cost, strengths, and weaknesses of the test methods available for evaluation of the hip status before making the choice of a specific testing method. Once the choice is made, it must be followed for generations before progress in improving the hip status can be evaluated. OFA data has demonstrated marked improvement of the hip status in the Portuguese Water Dog (AKC Gazette, Nov 1991) and the Chinese Shar Pei (Barker, Mar/Apr 1995). OFA data on all breeds was independently evaluated and reported by Dr. Kaneene (JAVMA, Dec 1997) an epidemiologist from the Population Medicine Center at Michigan State University. The study compared OFA evaluations on dogs born between 1972 and 1980 with dogs born between 1989 and 1992. The population consisted of 270,978 dogs. The authors, having acknowledged the fact that submissions are voluntary and that there is bias due to prior screening, concluded:

We do not believe that this is the most likely explanation, because the increase in the percentage of dogs classified as having excellent hip joint phenotype (+36% [7.82 vs 10.64%]) was substantially larger than the decrease in the percentage of dogs classified as having canine hip dysplasia (-21.% [17.39 vs 13.82%]). If better screening of radiographs

prior to submission to the OFA was the cause of the increase in percentage of dogs classified as having an excellent hip joint phenotype, then because it is easier to differentiate dysplastic hips from hips with normal phenotypes than it is to differentiate hips with excellent, good and fair phenotypes, we would have expected that the decrease in percentage of dogs classified as having canine hip dysplasia would have been larger than the increase in percentage of dogs classified as having an excellent hip joint phenotype.

Unfortunately, PennHIP has not been available long enough to accumulate the data necessary to evaluate the effect of this test method over time.

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