PENNHIP™: QUESTIONS AND ANSWERS

The following are a series of questions I sent to Dr. Gail Smith, and his answers, concerning PennHip. This exchange occurred via e-mail in June and July 1995, and was posted to the Golden Retriever e-mail discussion list (G@H) at that time. My questions are in italics.

Abbreviations

- **CHD** canine hip dysplasia
- **DJD** degenerative joint disease
- **DI** PennHip distraction index
- **OFA** Orthopedic Foundation for Animals

In the March-April 1995 issue of the Golden Retriever News, Dr. Corley of the OFA refers to a 1989 article "Examining Infant's Hips -- Can It Do Harm?" Dr. Corley writes "[this article]...raises the question that the examination procedure in the infant may actually cause a stable hip to become unstable. If this is true..." Clearly if one reads carefully, it is not clear that the examination procedure refered to is the same as the PennHip procedure, and there is implication that the article only raised questions, and did NOT actually conclude that the examination was harmful. Regardless, Dr. Corley's mention of this has now stirred up doubts and fears among Golden owners about the safety of having their dogs PennHip'ed. Concerning this issue, my questions are:

Can you briefly describe for the lay-person, how the actual x-rays and measurements are done? How is it different from the procedure for an OFA x-ray? Are you familiar with the article in question? If yes, it is the same exam procedure? Did that paper present any actual data documenting real harm done by the technique?

> For the PennHIP procedure, the hips are placed in a neutral (stance-phase) position and a small harmless distractive force is applied to displace the femoral heads laterally from the acetabulae. Every child in this country (and in most of the industrialized world) is evaluated similarly at a few days of age to assess for hip laxity. The technique is certainly not considered radical and if it were causing harm to the children, I feel that by now there would be clear evidence of such. The title of the paper cited by Dr. Corley, ends with the question, "Can it do harm?" precisely because the scant retrospective data from 3 maternity hospitals in England were not conclusive of any harmful effects. Certainly enough time has passed since the publication of this paper in 1989 that the question of "harmful effects" should have received legitimate epidemiological study at other maternity centers around the world. I am not aware of any such reports and I am confident that if such documentation existed, it would have already been brought to the attention of the breeding public by the OFA. The new distraction position differs markedly from the hip positioning specified by the OFA. In fact, this is why the distraction method has a 250%

improvement in sensitivity for measuring hip laxtity. The position of extreme hip extension used in the OFA method masks inherent joint laxity in all ages of dogs but particularly in puppies under 12 months of age. One should not lose sight of the fact that the OFA position is itself a stress-radiographic method that to my knowledge has not undergone safety testing. Also it must be recognized that the PennHIP procedure specifies that an OFA radiograph be made for each compression and distraction view made. Therefore, if indeed there were harmful effects of the multiple procedures, one would be unable to identify which procedure was causal.

After many studies and much close scrutiny of our data, we have no evidence to suggest that the procedure is any more harmful than the OFA stress-radiographic procedure. Our data is conclusive that neither procedure increases joint laxity in either tight- or loose-hipped dogs. Certainly in dogs having the extreme laxity and pain of CHD, any manipulation of the hip (eg., OFA, PennHIP or simple physical examination) may cause transient discomfort. However, no long term pain or untoward effects of such manipulation have been noted. To address your question of how the OFA method differs from the distraction procedure, consider the following example. The PennHIP distraction procedure is akin to pulling on your index finger while relaxing all your forearm musculature. You can appreciate displacement at your MCP joint (knuckle) and if you pull hard enough you may even elicit cavitation (cracking of the knuckle) however, the procedure itself is neither harmful nor exceedingly uncomfortable. Even people who acquire the habit of cracking their knuckles regularly in this manner, though socially annoying, do not suffer orthopaedic consequences of their habit. In contrast, the extreme hip extension of the OFA procedure is like taking your finger and bending it backward until it will go no further. I think you will agree that the latter procedure is more painful and that the discomfort lingers. Neither procedure, however, appears to be associated with long term pain or untoward consequences.

Do you think that the PennHip procedure might cause an otherwise HEALTHY adult dog, without CHD, to go on to develop joint disease? What about 4-6 month old puppies whose skeletal systems are not yet matured?

No. Not a single tight-hipped dog, irrespective of breed and age of first evaluation, has yet developed signs of DJD regardless of number of distraction procedures done throughout its lifetime. Longest followup is 9 years.

What about a dog that HAS CHD..could it be worsened by the PennHip exam?

Dogs with extant, clinically apparent disease can suffer transient discomfort stemming from any manipulation of the hip even routine orthopaedic examination. (See response to following question)

To the best of your knowledge, has anyone ever reported to you or to ICG that their dog developed hip problems as a result of the PennHip procedure? If yes, how many such reports in how many years?

Of the more than 6000 dogs evaluated thus far using the PennHIP procedure (3 radiographic views including the OFA view), fewer than 6 owners have reported that they thought the process

may have caused temporary discomfort. No long-term complications have been reported.

Could a dog who has no clinical symptoms of CHD, but has loose hips be at risk for harm from the exam? Dogs presenting without clinical signs are not made clinically painful in the short term by the evaluation procedure. In the long term, loose-hipped dogs having multiple PennHIP evaluations over their life appear to be no more at risk for developing osteoarthritis than those evaluated for the first time as an adult.

In your opinion, is the PennHip method any more or less risky to the dog than the positioning done for an OFA x-ray?

In my opinion, the distraction procedure is less painful than the OFA procedure. (see the finger-pulling vs finger-bending analogy above) I feel neither procedure has measurable risk for ill-effects to the dog.

As specifically as you can tell us, how many Golden Retrievers have been measured by PennHip, to date?

Roughly 700 Golden Retrievers have been evaluated by the PennHIP procedure. Their records form the basis for breed-specific information for Goldens within the PennHIP database. The most current (April, 1995) median distraction index for Golden Retrievers is 0.54. While this figure, at first, sounds discouraging, the fact that a wide range of laxity has been identified in your breed means that it is possible to apply substantial selection pressure to move this median toward tighter hip fit for the breed. This, of course, presupposes that laxity in Goldens has high heritability as found in other breeds studied thus far, eg, German Shepherd Dog laxity heritability is 0.61 and likely a minimum figure. As you know, it is the specific purpose of one or our current studies (funded by Morris Animal Foundation through gifts from the Seeing Eye and the GRCA) to evaluate hip laxity in Goldens relative to pedigree to arrive at an estimate of heritiability of hip laxity within your breed. Knowing heritability, we will be able to predict the expected rate of genetic change per generation from application of selection pressure. As important, a knowledge of heritability when combined with pedigree-based information of hip laxity for a given dog with respect to its relatives, will permit mathematical calcualtion of estimated breeding value (EBV) for that particular individual. EBV is an important statistic for it is an estimate of a dog's genetic merit. It helps to explain why two dogs of similar hip phenotype when bred to the same bitch may produce progeny with vastly different hip phenotypes between litters.

[Editor's note: As of Feb. 1997 over 2000 Goldens have been evaluated by the PennHip method.]

The next set of questions I'd like to pose deal with environment and hip dyplasia and joint laxity. There are some Golden breeders who believe that CHD is primarily hereditary, some the believe that it caused by environmental factors primarily, and many who believe that it is hereditary but that environment plays a role in expression of the disease.

As I understand the theory behind PennHip, ALL dysplastic dogs have loose hips, all tight-hipped dogs are free of CHD, some loose-hipped dogs are also free of CHD (the "false negatives"), and the looser the hip joints the greater the risk of developing joint disease. Although some loose-hipped dogs never get CHD, NO tight-hipped dogs ever get CHD so

that selectively breeding for tight hips would be one way to reduce the incidence of CHD in dogs. Is this correct?

Yes, however I would like to make a distinction between CHD and DJD. In my research I chose to study the role of passive hip laxity in the development of degenerative joint disease (DJD = osteoarthritis). DJD is the undisputed hallmark of CHD. CHD, classically defined, is the radiographic evidence of DJD and/or subluxation of the hip (subluxation is radiology-speak for passive hip laxity). By convention, a hip can, therefore, be graded as dysplastic without showing evidence of DJD. In the past, because DJD was not distinguished from subluxation in the subjective scoring scheme, the precise role of passive hip laxity on CHD diagnosis was indeterminate: the independent variable, hip laxity, was included in the definition of CHD. To avoid confusion in your question above and in my answers to follow, I would recommend replacing "CHD" with "DJD." One point of clarification; the "theory' you mention in your question should not be interpreted to mean "theory" in the speculative sense, but rather, a statement of the general principles of a body of science.

*IS *joint laxity* hereditary in Golden Retrievers?*

We have shown that the distraction index has high heritability in German Shepherd and in Laborador Retriever breeds. The OFA has not published comparable breed-specific heritability figures from the standard subjective scoring method in practice since 1966. As a rough estimate from other studies in the literature, the heritability of DI is 50% to 140% higher than estimates of the subjective (OFA-type) phenotype. Breeds of dogs are more similar than different and therefore, I feel there is every likelihood that hip laxity will be heritable in Golden Retreivers as well. The question we are addressing in our research of the Golden Retriever breed is, "How heritable?" As I mentioned in the last round of questions, knowing the magnitude of heritability allows one to predict the rate of genetic change for each generation of selective breeding and heritability is integral to calculating individual estimated breeding values. I would like to remind those who are skeptical that the absence of research results documenting the magnitude of heritability of hip laxity in Golden Retrievers is not tantamount to a conclusion that the heritability of hip laxity in Goldens is zero.

What factors other than heredity affect joint laxity? Can environmental factors such as diet, vitamin supplements (vitamin C for instance), medication, exercise, etc. effect joint laxity?

Many environmental factors have been suggested to affect joint laxity, eg, diet, vitamin supplements, activity, medication, etc, however, to my knowledge only 3 factors have received adequate scientific investigation. They are 1) restricted food (caloric or protein) intake, 2) Oral "DAG", dietary anion gap, and 3) Intramuscular PSGAG's, polysulfated glycosaminoglycans. In each of the studies the beneficial effect of the factor evaluated resulted in a 'tightening' of hip laxity by a small amount, 3-5 Norberg angle degrees, as determined from the standard radiographic view. Though the reduction in hip laxity was small, the benefit was a measurable reduction in susceptibility to DJD. Interestingly, for the studies above in which the distraction procedure was also performed, the distraction index was not affected by these environmental influences.

This was an encouraging finding because a phenotype that is uninfluenced by environmental factors is more desirable (and has higher heritability) than a phenotype that is influenced by environement. You are probably aware of the concept that "Phenotype = Genotype + Environment". As environmental influences on the phenotype are minimized, the phenotype approaches the genotype. Obviously, such a phenotype would have great benefit for those wishing to improve the gene pool by application of selection pressure.

Can these environmental factors cause an otherwise tight hipped dog to develop loosehip joints and hence become at risk for CHD due to environment not heredity?

As previously mentioned, hip laxity from the standard hip-extended radiographic view is more affected by environmental factors than the distraction radiograph. For example, from the restrictive-feeding study cited above a thin Labrador retriever may have a tighter appearing hip on the standard view than if the same dog were obese. The distraction view for either body condition would show similar laxity. Excluding trauma, I am not aware of any environmental factors that can make a tight hip as determined by distraction radiography become loose.

Can medical conditions cause joint laxity? Conditions such as hypothyroidism, etc. which may or may not be hereditary themselves?

The influence of medical conditions on passive hip laxity is not well studied. One might suspect that immune-mediated arthroses like rheumatoid arthritis or lupus erythematosus or infectious arthritides like Lyme disease or Ehrlichiosis, may cause increased joint laxity, however, I am not aware of studies to support such a possibility.

Common "knowledge" (myth? folklore?) holds that a bitch's hips are more lax while she is in heat and that OFA x-rays are best done on bitches when they at least 1 month out of heat and no closer than 1 month to being in heat. Is there any PennHip data to support or refute this? Are current PennHip studies taking into account the stage in estrus cycle of bitches when PennHip'ed?

The influence of estrus on hip laxity is insufficiently studied. A report out of the University of Missouri in 1993 found no significant difference in hip laxity between anestrus and estrus or between diestrus and estrus, however, hip laxity in this small study was not evaluated during proestrus, a phase when estradiol levels are reported to peak. One of my surgery residents, Dr. Kirk Hassinger, and I have recently received a grant to study the effect of phase of estrus on passive hip laxity as measured by the distraction index. The study is ongoing and should be completed within a year. EMPIRIRCALLY, my impression from doing the distraction procedure on performance-bred Bozois (a uniformly tight-hipped breed), is that there is no obvious increase in joint laxity associated with estrus. Stay tuned for the results of the current investigation.

Can joint laxity be changed? Is there anything that can be done to tighten up the hips of a loose-hipped dog and thus reduce that individual dog's risk of developing joint disease? What environmental conditions might cause a tight hipped

dog to become loose hipped?

Feeding rations low in DAG, keeping dogs thin or administering PSGAG's to puppies may provide a small tightening effect to the hips of dogs as measured from the standard hip-extended radiograph, and confer to them some resistance to DJD (see above). The distraction index (DI) of such dogs, however, remains relatively unchanged in spite of environmental influences. I have not encountered any environemntal conditions (except perhaps, trauma) that would cause tight hips (low DI) to become loose. Your question is a good one and we are exploring strategies to make the hips of dogs more DJD-resistant. You recognize, of course, that such an "environmentally" improved phenotype in a dog would have no effect on improving the breeding value of the dog.

Is is possible for joint laxity to vary in an individual dog as a function of age?

Riser's studies showed that puppies are born with normal hips and Lust has reported that hip laxity develops before 16 weeks of age. Our studies document that hip laxity by distraction radiography after 16 weeks of age remains fairly constant. My post-doc, Chris Hill and I are putting the finishing touches on a paper showing that hip laxity in German Shepherd dogs at 8-weeks of age is not statistically predictive of later joint laxity. Specifically 18% of the dogs in this longitudinal study developed markedly increased hip laxity between 8 weeks and 16 weeks. Thereafter hip laxity remained constant. Most age-related changes in hip laxity, therefore, appear to occur in the period before 16 weeks of age. It is important to recognize that the changes in hip laxity observed were uniformly from tight to loose and not loose to tight.

Do joints loosen with age? Could puppies be loose-hipped when less than 1 yr old and tighten up as they mature?

A 3-year, longitudinal study that I published in American Journal of Veterinary Research in 1993, showed that hip laxity (DI) remains relatively constant after 16 weeks of age. Our published longitudinal studies have not gone beyond 3 years of age, however, I do not suspect that hips either loosen or tighten with age. Support for this view comes from collaborative efforts at research facilities other than Penn where in one case a pool of Labrador retrievers is being followed for life (currently the Labs are 9 years old). Also, the observation that breed-specific hip laxity of older dogs (5 years old) is not different in distribution from younger subsets of breed members is indirect evidence that joint laxity (DI) doesn't change significantly with age.

With regard to the actual PennHip positioning and measurement itself, and the DI results: What is the anesthesia protocol? Many of us whose dogs were done at the Austin clinic were disturbed at the mix of sedatives used and the length of time (9-10 hours) required for the dogs to recover from the sedation. Is this necessary?

[Editor's note: The Austin Golden Retriever Club had a PennHip clinic in June 1995, at Anderson Mill Animal Clinic in Austin, TX. Dr. Smith's post-doc came down to assist with the clinic.]

All PennHIP Members are veterinarians and the selection of sedation/anesthesia to perform the

PennHIP procedure (and there are many to select from) is at the individual veterinarian's discretion so long as the dogs are sufficiently sedated to obtain full hip distraction (and, of course, so long as the drugs and dosages used are safe). When I first heard of the prolonged recoveries, I too was shocked. In reviewing the sedation protocols used at the Austin clinic, I noticed that Acepromazine had been administered as one of the sedatives in the majority, if not all, of the evaluations performed. In my opinion the prolonged recoveries were directly attributable to the use of Acepromazine. This is not to say that the drug is unsafe or that it shouldn't be used, (and my comment certainly should not be construed as a criticism of the Austin clinic). At Penn I (personally) avoid using Acepromazine because of the variability in its action from dog to dog and the typically prolonged recovery time. Rather I use either a combination of oxymorphone and valium (followed by a narcotic antagonist to reverse the effects of the narcotic). Alternatively, I use a new drug called Propofol. Following either of these drug protocols, dogs are capable of ambulating within approximately 15 or 20 minutes. The protocols are safe, (no injuries or deaths in more than 2000 evaluations). An occasional owner will comment that their dog may whimper a bit in the hour or two following the sedation. Such behavior is attributable to the narcotic, oxymorphone, and is harmless and self-limiting. The disadvantage of the drug protocols used at Penn, however, is that they are very expensive ($20.00/dog cost to the veterinarian). Given the limited funds to conduct the many evaluations at the Austin clinic, I consider Dr. Fuller's use of Acepromazine justified. I would estimate that it reduced the need for other more expensive sedatives by at least 50%. Breeders or dog owners requesting the PennHIP procedure should feel free to discuss with their PennHIP veterinarian the sedative/anesthesia protocol their dog will receive and the nature and expected length of recovery. Many veterinarians will offer you a choice depending on your preferences. Understand, however, that sedative protocols vary greatly in cost to the veterinarian and accordingly in price to you.

What about the force applied, particularing for the distraction view. Is a uniform amount of force used? Is it measured? Is there a problem with different vets applying different amounts of force? Can variations in force effect the measured DI? Could a vet who wanted a reputation for getting low DI results on his x-rays do this by applying less force than was supposed to be used? Could ICG detect this on the x-ray?

These are very important questions. I am aware of the distribution of information by the OFA to breed clubs stating that the force applied for the PennHIP procedure "varies from study to study and from investigator to investigator," suggesting that the repeatability of the PennHIP procedure from veterinarian to veterinarian is poor. Had I been contacted by Dr. Corley, the Director of the OFA, prior to issuing this "opinion" I would have gladly shared with him the results of mechanical testing of canine hips from experiments conducted in my research laboratory in the Department of Orthopaedic Surgery at Penn's School of Medicine. A research paper on this topic should appear in the literature within the coming year. In fact, contrary to Dr. Corley's contention, the PennHIP procedure is extremely repeatable particularly for a biological parameter. The mean error in repeated measurements of the same dog by the same examiner at one anesthetic episode is less than 4 percent. The explanation for high repeatability even in the absence of calibrated force is rooted in the inherent mechanical behavior of the canine hip. That

is, the sedated canine hip when pulled laterally in the PennHIP position does not behave like a spring, ie, linearly (meaning the harder you pull the more it displaces laterally), but rather its load/displacement behavior is sigmoidal. This means that only a small force (less than 10 Newtons = 2.2 lbs.) applied locally is sufficient to cause 90% of the potential measurable hip displacement. Any additional force applied to the hip acts to create displacements between 90% and 100% (in other words a maximum theoretical error of 10%). This laboratory data was substantiated by our subsequent clinical trials in live dogs. In fact, our studies of between-examiner repeatability in positioning sample populations of live dogs for the PennHIP procedure yielded results better than the max. 10% error theorized from cadaver hip studies. The intraclass correlation coefficient between examiners was 0.95 meaning that the error in the analysis of variance was approximately 5%. I realize this all sounds like statistical/mechanical mumbo jumbo, however, the point is, that the PennHIP procedure has high repeatability both within- and between-examiners without the need to "standardize" or measure the force applied to the hips. In fact, each PennHIP trainee as part of the official certification exercises must satisfy rigid repeatability criteria. That is, the error (variation) in repeated distraction radiographs must have a standard deviation not exceeding 0.05 distraction index units. As part of our analysis we have also done studies of the repeatability of hip laxity from the standard hip-extended view (this, too, is in preparation for publication). The error in measurement of joint laxity from the hip-extended view is 4 to 6 times the error from the distraction position. Also, I have stated in a previous Q&A piece that the absolute magnitude of laxity measured by the PennHIP procedure is 2.5 fold greater than by the hip-extended radiographic procedure. Therefore both the precision and sensitivity of the PennHIP procedure is superior to the hip-extended procedure.

Regarding the possibility to create fraudulently tight DI's, I have implemented several safeguards to prevent this from occurring. For obvious reasons I do not wish to divulge all of them. One safeguard is that PennHIP members are taught that if a dog's hip(s) appears to have a tight DI, the distraction radiograph should be repeated. Because of the known mechanical behavior of the hip (as described above), it is extremely unlikely that a second fraudulent radiograph would have comparable joint laxity. If the variability of the 2 views is too great the films will be rejected and the dog will have to be repeated. Another safeguard is that the distractor is designed to indicate the approximate magnitude of applied load. It would be apparent if someone were intentionally applying too little force. Happily, I have no evidence to suggest that anyone is cheating. Cognizant of the ways of the world, however, we will be ever vigilant. We discovered early that a fairly common mistake made by PennHIP veterinarians was undersedation of the patient. This shows up as hips with no joint laxity whatsoever and is easily recognized by the veterinarian so that appropriate corrective measures can be taken.

What is the error in the measurement? What variation in the DI number is sigificant? Is a Golden with DI of 0.46 significantly different, or within error, of the breed median of about 0.56? Is a Golden with DI of 0.46 significantly different from one with DI of 0.44, or they the same for all practical purposes? Does this vary with breed? Kathy Carbone asks: If 10 dogs were PennHip'ed 3 times each over the course of a year, how much variation would you observe in measured DI values in the each dog?

[Editor's note: Kathy Carbone, Soncy Goldens, is breeder and a regular contributor to the Internet Golden list discussions.]

I addressed 'error in measurement' in the response above. Regarding whether a dog with a DI of 0.46 is significantly different from one with a DI of 0.56, I would estimate (without actually performing the calculation) that it is significantly different (ie, consider an 18% difference in measured laxity with only a 4% error in measurement). But your specific question is more complicated, does a DI of 0.46 differ from the population mean of 0.56? The population mean DI is the average joint laxity of Golden Retrieverss of all ages (over 16 weeks of age). One must therefore estimate and incorporate the error (variation) in DI for individual dogs over time. Specifically, if one factors in the variation of DI over time, 0.46 may, in fact, be within the 95% confidence interval of the median, 0.56, (and therefore one could not be 95% certain that 0.46 was truly [significantly] different than 0.56). This question is very important and was precisely the focus of the paper I published in 1993 in the American Journal of Veterinary Research (Vol 54,pp. 1021-1042). This paper also directly answers the question raised by Kathy Carbone regarding the variation in measurement of several dogs over time. (Again, this information is readily obtainable by contacting ICG). The best statistical test used to determine the comparability or "sameness" of score over time is the "intraclass correlation coefficient". Figure 4 in the publication cited above shows the actual data for hip scores of a pool of 39 dogs measured both at 4 months and 24 months of age. The intraclass correlation for DI was 0.85 meaning that the error term in the analysis of variance was the complement, 15%. Fifteen percent error is by no means perfect but very, very good when compared to the repeatability of joint laxity from the same dogs evaluated in the hip-extended position where the error was found to be 49% (intraclass coef = 0.51). A closer look at figure 4 shows that while the average dog did not change very much in DI from 4 months to 24 months of age, a few outliers in the tails of the distributions showed appreciable changes, eg, one dog was 0.25 at 4 months and 0.43 at 24 months, another was 0.62 at 4 months and 0.47 at 24 months. Again, these changes represent the tail of the normal distribution. It is important to note that the changes in DI with time were much smaller than laxity changes seen from the same pool of dogs positioned in the standard hip-extended orientation, eg, one dog had a Norberg angle of 107 degrees at 4 months which went to 86 degrees at 24 months, another example had a NA of 91 degrees at 4 months which went to 105 degrees at 24 months. If your dog happens to be in the tail of the DI distribution relative to time-based variation, its hip laxity will likely show greater discrepancies with time than if your dog is near the mean (which most dogs are) where the change in hip laxity with time when measured using the distraction procedure is small. The observed variation in DI with time is even smaller as dogs reach adulthood. For example, the intraclass correlation coefficient for comparability of DI from 12 months to 24 months of age is an astoundingly high 0.93.

With this said, I personally believe that too much 'hair splitting' is occurring in the interpretation of a dog's DI. What is incontrovertible from our years of research at Penn is that "tighter hips are better hips." While it is possible that a dog with a DI of 0.2 at 4 months of age may in the extreme case change to a DI as high as 0.35 at 12 months of age, it is highly improbable that the DI could

ever become 0.9,0.6, or even 0.4. Because of the better comparability and the increased confidence from averaging DI scores at different times, I recommend repeating the PennHIP procedure as the dog matures, particularly for potential breeding stock. It is important to mention that in the same paper cited above, the repeatability (prediction) of OFA-type scoring from 4 months to 24 months was NOT found to be statistically significant.

What is the observed, presently known, range of DI values in Golden Retrievers?

Please recognize that the range is not a very good descriptor of the distribution of data, however, for Goldens DI ranges from a tight of 0.17 to a loose of 1.21.

Is there any correlation of OFA rating and DI value in Goldens? Are OFA Excellent or Good Goldens more likely to have lower DI values? Can you give us statistics on what percentage of Goldens with DI less than 0.3 have OFA Excellent ratings, have OFA Good, and have OFA Fair ratings? Is there anyway to estimate DI values of past Goldens based on their OFA ratings so that breeders might use existing pedigrees to evaluate inheritance of DI in their specific bloodlines?

We currently do not have enough Goldens in our database (that were evaluated both by PennHIP and the OFA) to make the correlations you have requested. The data we do have, however, does not appear to deviate from what we will shortly publish from multiple breeds of dogs regarding the correlation of PennHIP to OFA. There is a mild correlation between OFA score and DI. In general, dogs with tight hips by DI are passed by the OFA, however, the converse is not true. There is considerable overlap in the DI's relative to each OFA scoring category. For example, 48% of the dogs receiving a score of 'excellent' from the OFA had DI"s below 0.3 while 36% of the 'goods' and only 8% of the 'fairs' were below a DI of 0.3. It was a telling discovery that within the OFA 'excellent' category hip laxity ranged to as loose as DI=0.61; within the 'good' category, to 0.77; and within the 'fair' category, to 0.91. It is clear that many dogs with marked joint laxity by DI get approved for breeding based on tight-appearing hips on the hip-extended radiograph. It is notable from this study that of the dogs certified for breeding by the OFA, 77% had DI's greater than 0.3 and were therefore in the DJD-susceptible category.

Relating to the above question, in your talk at the GRCA 1994 Nationals you presented some VERY interesting statistics on the correlations of OFA ratings assigned by several different OFA vets to the same x-ray, and correlations of OFA ratings assigned by the same vet to duplicates of the same x-ray. It was VERY revealing about the consistency (or lack of) of the OFA method, and had important implications regarding how seriously to take the different OFA Excellent versus Good versus Fair ratings. Could you share those statistics with us here?

The study to which you have referred will likely be published in the coming year. We had several board certified radiologists read the same set of radiogrphs to analyze the variation in subjective scoring. Two radiologists were not affiliated with the OFA, one was an OFA reader and all films had been officilly read by the OFA. I cannot go into the statistical details of the study, however, the diagnostic variability between radiologists was very large ranging from 5 to 65%. In the pool of dogs evaluated, the non-OFA radiologists failed 2.5 to 3 times the number of dogs failed by the OFA. While the OFA radiologists appeared to be fairly consistent (good precision) in their

scoring, there was no means of determining method accuracy. That is, the hip phenotype that should become the standard is the one with the highest heritability. In spite of almost 30 years of selective breeding using the OFA criteria, such studies, to my knowledge, have not been performed.

The following questions were put to Dr. Smith by Golden Retriever breeder Kathy Partidge.

1. I recently made an appointment with my (PennHIP) vet to have my 3-1/2 year old Golden bitch x-rayed. I was mostly interested in having the OFA done, but figured I might as well do a PennHIP while she was there since it would only add about $30 to the total cost. However, my vet talked me out of the PennHIP, saying that it was only useful for evaluating young puppies, and there wasn't much to be gained by PennHIPping an adult bitch since OFA is still the breeding standard. Why did he do this? I was thinking that the PennHIP info on this girl would be useful to have at a later date if PennHIP does become the yardstick of the future, even if I bred her now based on the OFA info.

You were correct in your understanding of PennHIP rationale. All dogs evaluated whether puppies or adults are valuable data points in an expanding database. For example, in the analysis of heritability, the full pedigree is examined and to the extent that your bitch is a member of that pedigree, her measured phenotype has importance. Also, her individual DI when considered in the context of the Golden Retriever DJD-susceptibility curves (not yet published), will give you an indication of her disease predisposition. Although each breed may have greater or lesser susceptiblity to DJD as a function of hip laxity, all breeds studied to date have in common that the tight-hipped members show virtually no susceptibility to develop radiographic evidence of DJD. The PennHIP analysis also ranks your dog's hip laxity relative to other members of her breed. Irrespective of her OFA score, if her hip laxity is in the middle of the distribution for the breed she would be less valuable as a breeding dog than if her hips were within the tightest 10th percentile. We will shortly publish a paper that shows that 71% of the dogs certified for breeding by the OFA (Exc, Good or Fair scores) have distraction indices above a DI of 0.3, (the loosest hip to pass OFA in this particular analysis of 167 dogs was a DI of 0.91 in a Portugese Water Spaniel). In contrast, dogs found to have tight hips by the distraction procedure rarely are scored dysplastic by the OFA. We do not discourage the use of subjective OFA-type scoring (in fact, we mandate that the standard hip-extended view be included as part of the PennHIP evaluation), however, a bitch who has passed both OFA and has tight hips is likely a better breeding candidate than one that has passed OFA but harbors loose hips.

2. You wrote: I am interpreting the above statement to mean: a. We do not yet know what the heritability of CHD as measured by the c/d technique is in Goldens. b.The GRCA/Seeing Eye study is underway to determine this. Also, my impression is there are actually two aspects to the c/d technique: 1. The measurement of joint laxity via the compression and distraction views (which I'm not questioning - over the last couple of years, I've collected and read most of the journal articles you referenced) 2. How this joint laxity is inherited; what its heritability is within individual breeds, how this information can be used as a breeding tool. With regard to Golden Retrievers, why is the c/d technique, particularly with the unknowns of aspect #2 (above), being commercialized (PennHIP) and promoted to breeders as being "the answer" before we know it to be so? Is this not what OFA has done for 30+ years? ("Trust us, it works, you'll see") How can ICG tell us that PennHip works as a breeding tool at the same time you're saying you need us to

*participate in your studies to *see* if and how it works? This makes no sense, and IMO *this* is where most of the resistance to your work is coming from.*

I disagree with your contention that it is premature to offer PennHIP as a clinical tool. First, it is not relevant to the breeds of dogs that benefit from the technology, whether the technology is offered through a not-for-profit organization like the OFA or through a company like ICG, particularly when the not-for-profit concern charges the end user, the breeder, the same as the for-profit concern. It is important to appreciate that "not-for'profit" is a tax status and not an indication that the entity is engaged in philanthropic or research activities. Second, all research to date in the German Shepherd, Labrador, Rottweiler, Borzoi and Greyhound breeds show that 1) tight hips are not susceptible to acquiring DJD, 2) loose hips are susceptible to developing DJD, 3) the greater the hip laxity, the greater the susceptibility to developing DJD, 4) hip laxity can be predicted from 16 weeks of age and 5) heritability of DI in the German Shepherd and Lab breeds is higher than the heritability of the subjectively scored hip phenotype derived from the standard method of hip positioning. The work from my laboratory has more than satisfied the burden of scientific proof that the method has distinct advantages over the OFA method. As I stated in an answer to a question in an earlier post, dogs are more similar than different. With the wide range of laxity in the hips of Golden Retrievers it is extremely likely that the patterns observed in the breeds mentioned above will also hold for the Golden Retriever breed and heritability will be high. Particularly since we have evidence that these patterns even cross species lines, ie, they are applicable to cats and man. Can you cite evidence or suggest substantive reasons why the findings from studies of German Shepherd dogs should not apply to Golden Retrievers?

Third, if the science and logic is sound, the admitted absence of specific information on Goldens, should not prevent those breeders wishing to accept the PennHIP research from having access to the method, so long as it does not cause harm (covered in a previous Q&A). If you are not convinced that the method has potential for improving the hips of your Goldens, then by all means forgo PennHIP until you are satisfied with our results and our motives. You have every right to want more data on your specific breed, but other breeders have the right to have access to this new technology with the clear understanding that not every detail for every last breed has yet been fully worked out. In medical science it is not uncommon to extrapolate from race to race or even across species lines when determining the safety or efficacy of a new treatment or medicament. The FDA requires that a new drug or orthopaedic device be evaluated relative to standards within the same drug or device category. WRT hip dysplasia diagnosis, historically the OFA has been the standard and our studies have long showed superiority over it, Dr. Corley's unfounded protestations notwithstanding. Your characterizing my position as being similar to that of the OFA, "Trust us, it works, you'll see," is unjust and gives no credibility to the science performed in my laboratory since 1983.

Finally, the funding I receive indirectly from the GRCA by way of Morris Animal Foundation permits my laboratory to focus on the genetic aspects of CHD specific to the Golden Retriever

breed. It is not funding the development of PennHIP methodology completed years ago. Genetic data up to the point of GRCA funding were derived from closed populations of pure bred dogs at the Seeing Eye Prior to initiating PennHIP monitoring, The breeds studied at the Seeing Eye had undergone generations of selection relative to hip disease using a subjective scoring system similar but more stringent than that of the OFA. The Golden Retriever breed was a desirable focus of scientific study, on the other hand, because the size of the population was large and the range and mean hip laxity was high. From the breed hip-laxity profiles,it was clear, also, that there had not been extensive selection away from loose hips. I accepted an invitation from the leadership of your club to submit the proposal that ultimately was funded. By the way, I turned down similar requests from other breed clubs. The research wasn't so much designed to address the question of "if it works" but more the genetic details of "how well it works in Golden Retrievers." Also as part of the research my colleague, Dr. Eldin Leighton, and I proposed to develop the mathematical relationships to arrive at individual estimated breeding values from an analysis of the full pedigree in open, not heavily pre-selected populations of dogs. Clearly the latter objective will require monitoring Goldens for more than one generation, however, the initial 3-year program should get us well on our way toward that objective.

3. As a breeder, I feel I'm being bullied into accepting PennHIP (while it is still being studied, no less); I'm being told that unless I embrace PennHIP, I'm a bad, irresponsible breeder who doesn't have the best interests of Goldens at heart. I've heard this philosophy both from Melissa Goodman in private correspondence, and in public postings from Scarlette Gotwals, DVM (apparently a PennHIP vet) on this Golden list. This hardly seems like a good PR approach and such a "hard sell" from ICG reps - a commercial entity with stockholders to answer to - immediately makes me suspicious and resistant to the entire PennHIP program. I can't think of any other company that uses denigration of prospective clients as a marketing tool for its products and services! Since ICG's approach would seem to be undermining your efforts at acceptance, I'd be interested in hearing your comments.

The denigration has emanated from both sides. One has only to read this thread for the past few weeks to appreciate the hostility. Such inflammatory discourse is NOT productive and it should stop. At this point it does not benefit your breed to debate which side struck the first blow. I suggest that we adopt the policy to agree to disagree without being disagreeable. If, after studying the science to support the method, you believe that the PennHIP technology holds no promise to benefit your breeding program, do not use it. I ask only that you maintain a position of informed skepticism, rather than misinformed skepticism.

If you feel you are being mistreated by ICG personnel, I suggest you contact ICG. The president of ICG, Paul Rosinack, has informed me that he would welcome the opportunity to discuss ICG's involvement with PennHIP and respond to any concern you may have (800-248-8099). Interestingly, I am told only a few individuals on Golden-L have bothered to contact ICG for information or clarifications. Regarding your "suspicion and resistance to PennHIP because of its involvement with a commercial entity," please suggest to me alternative means of implementing the PennHIP technology and building a large multibreed database given that the most logical means, the OFA, has consistently shunned this technology since I first proposed it to the OFA

in 1983.

4. Do you still work at Penn, or are you now an employee of ICG (or both)? Many of us are confused as to the exact relationship between you, ICG, and Penn Vet School. (I am aware that the latter is teetering on the brink of bankruptcy.)

First let me allay your fears; Penn Vet School is not teetering on the brink of bankruptcy. The much-publicized dilemma last year regarding the Vet Shool's solvency was actually a political and philosophical standoff between the governor of Pennsylvania and the President of Penn. In spite of the publicity and the compounding effect of the fairly deep recession, there were no furloughs, layoffs or paycuts at Penn, in contrast to the situation at most veterinary schools in the US. Unlike other Vet schools, Penn receives only 40% of its operating budget from the state (rather than 100%) and therefore the impact of flucutations in state appropriations has less of an impact. Since this unfortunate period of negative publicity, the economy has improved, the incumbent governor was not reelected, Penn got a new President and happily our funding woes appear to be over for the near term at least.

Second, your concerns about my relationship with ICG were raised by the leadership of the GRCA when I first revealed to the GRCA that the PennHIP technology had been licensed to ICG, December, 1993. The questions regarding my use of GRCA funding in the face of the PennHIP/ICG licensing agreement were put to the Morris Animal Foundation by the leadership of the GRCA. I responded immediately and adamantly to the MAF that there was absolutely no wrongdoing on my part as an academic investigator and grant recipient and that at no time currently or in the future would (or could) the GRCA funds be comingled with those of ICG. I had hoped the content of this message would have been disseminated by the GRCA leadership to the members at large.

Yes, I continue to be a full-time faculty employee at Penn. My rank is Associate Professor with tenure and I am Chief of Surgery. The licensing of the PennHIP technology by ICG was arranged through the University of Pennsylvania Office of Technology Transfer. I have limited consulting activities with ICG (approx. 2 days/month) which include among other things, conducting the PennHIP seminars, certifying veterinarians to perform the C/D procedure and quality-assurance on the technical aspects of the method. All agreements and my involvement with ICG have been reviewed and approved by an independent committee at Penn concerned with potential conflicts-of-interest. In summary, the entire arrangement has been done by the book. In my opinion, the agreement between Penn and ICG represents an excellent example of the kind of cooperation that can be achieved between academic institutions and industry, for the benefit of the public sector. If you are questioning why I chose to align PennHIP with a for-profit concern, I proposed to the OFA as early as 1983, the technology that ultimately became PennHIP, however, there was then, and continues to be, no interest from the OFA. It certainly would have been easier and better advised to join forces with the OFA than to go forward as adversaries.

5. Now that ICG is collecting Golden data via PennHIP, why can't you get your heritibility study stats from them? Why do

you still need the GRCA/Seeing Eye funding? Why the redundancy (is there redundancy)? As long as it's continuing, do you (not some other ICG representative) have any plans to give the GRCA membership an update on the progress of the study? We have seen very little information published in the GRNews; all we get are appeals for more donations to the cause.

In fact, the original grant to Morris Animal Foundation (and GRCA) contained plans to use data whenever possible from the expanding PennHIP database. However, such information would be supplementary, at best. A research project has objectives and a timetable and it was not possible to design an experiment around the chance that Golden Retriever breeders would pay full price and bring to Penn the right number and right mix of Golden families. The tendency for breeders to preselect puppies prior to evaluation is well-recongnized and such a practice runs counter to the aims of this research. I chose to base the study at Penn to maximize control of potential sources of experimental error. The GRCA money (in combination with Seeing Eye, Inc money) gave me incentive to focus on the Golden Retriever breed and it allowed me in turn to provide financial incentive for breeders within driving distance from Philadelphia to have their litters evaluated. In spite of numerous invitations, however, the willingness of local breeders to get involved has been less than anticipated. I am encouraged and appreciative of the recent PennHIP effort in Austin (Thanks Kay), however, it must recognized that increased costs to the grant were incurrred.

Regarding the progress of the study, I am in complete compliance with the policies of the Morris Animal Foundation in submitting progress reports. For legitimate reasons, these reports are confidential and are shared with the leadership of the funding group, in your case, the GRCA. I understand there may be a snafu over the confidentiality issue between MAF and the GRCA leadership, however, I don't pretend to be informed on this matter.

Apart from the legal issues, however, my professional colleagues will tell you that I am very liberal as a scientist when it comes to sharing my research data, even before it is published. That is not to say I am willing to divulge all information, but within the context of the severe time constraints on me, I have not refused a request to release available information. Although I understand alot of e-mail and snail-mail go on behind the scenes, (among yourselves and between your leadership and MAF), I, personally, have never been directly phoned or contacted by the GRCA leadership about the progress of my research. I take seriously my obligation as an educator and academician to inform the public and I am open to any reasonable request from the leadership of the GRCA.