Introduction to Canine Hip Dysplasia

The word dysplasia stems from the Greek words dys, meaning "disordered" or "abnormal", and plassein meaning "to form". The expression hip dysplasia can be interpreted as the abnormal or faulty development of the hip. Abnormal development of the hip causes excessive wear of the joint cartilage during weight bearing, eventually leading to the development of arthritis, often called degenerative joint disease (DJD) or osteoarthritis (OA). The terms DJD, arthritis and osteoarthritis are used interchangeably.

Canine Hip Dysplasia (CHD) was first described in 1937 by Dr. Gerry B. Schnelle. Dr. Schnelle initially called it "bilateral congenital subluxation of the coxofemoral joint". It was originally thought to be a rare condition but is now recognized as the most common orthopedic disease in dogs. The radiograph image on the left is the first known example of CHD to be published in a scientific journal.

In 1966, Henricson, Norberg and Olsson refined the definition of CHD describing it as: "A varying degree of laxity of the hip joint permitting subluxation during early life, giving rise to varying degrees of shallow acetabulum and flattening of the femoral head, finally inevitably leading to osteoarthritis."

Today, the general veterinary consensus is that hip dysplasia is a heritable disease manifested as hip joint laxity that leads to the development of OA.

Canine Hip Dysplasia afflicts millions of dogs each year and can result in debilitating orthopedic disease of the hip. Many dogs will suffer from osteoarthritis, pain, and lameness, costing owners and breeders millions of dollars in veterinary care, shortened work longevity, and reduced performance. The occurrence of CHD is well documented in the large and giant breed dogs, but there is also evidence that CHD is prevalent in many small and toy breeds as well as in cats.

Hip dysplasia is a disease of complex inheritance, that is it is caused by many genes. Veterinarians and dog breeders have attempted to eliminate CHD through selective breeding strategies. However, the reduction of CHD frequency in pure-breed dogs has been disappointing.

Fast facts about Canine Hip Dysplasia

- Canine hip dysplasia (CHD) is the most commonly inherited orthopaedic disease in dogs.
- CHD is a degenerative, developmental condition, leading to painful hip osteoarthritis, stiffness, and diminished quality of life.
- All dog breeds are affected by the disease, in some breeds more than 50% of dogs are afflicted.
- The development of CHD is affected by environmental factors such as weight and age.
- There is no medical or surgical cure for CHD.
- CHD is a major concern for working dogs, pet owners, breeders and veterinarians.
The Development of Canine Hip Dysplasia

Canine hip dysplasia (CHD) is a developmental disease. A developmental disease is not present at birth but arises with age. The series of radiographs below illustrate how a loose hip gradually develops osteoarthritis (OA).

At six months, this dog's hips exhibit extreme laxity, but no OA.

At 15 months, laxity is accompanied by the development of "mild" to "moderate" OA: the femoral heads appear slightly "flattened", the femoral necks are beginning to thicken and the acetabular rims are in the early stages of remodeling.

At six years, OA has progressed into a "severe" form, marked by extreme bony remodeling of the acetabular cups and the femoral head and necks.
Clinical Signs of Hip Dysplasia

Canine hip dysplasia (CHD) in its severest form can be diagnosed by clinical signs, but it usually requires radiographic evidence of hip joint laxity and/or the appearance of osteoarthritis (OA) to arrive at a definitive diagnosis.

There is an acute and a severe form of CHD. An affected dog may have one or any combination of the following clinical signs:

**Severe (Acute) Phase**
- Presentation at five to 12 months of age.
- Overt pain, lameness, and functional deficits (low exercise tolerance, reluctance to climb stairs) and
- Other signs: audible "click" when walking, increased intertrochanteric width ("points of hips" are wider than normal), thigh muscle atrophy.

**Mild (Chronic) Form**
- Clinical signs ranging from none to mild.
- Mild discomfort and stiffness in geriatric years and
- Possible pain and crepitus on range of motion.

Clinical signs by themselves do not necessarily mean that a dog has hip dysplasia, other conditions of the hip can mimic CHD. A radiograph is essential for a more accurate assessment of the dog's hip joint integrity.
Hip Laxity

Defining Hip Laxity

Hip joint laxity is the most important risk factor for the development of osteoarthritis. In other words, the amount of laxity or looseness in a hip joint is related to the chance that a hip will develop OA: the looser the hip, the greater the risk. For this reason, it is important to understand the difference between passive and functional hip laxity.

- Passive hip laxity is subjectively scored or measured on a hip radiograph of a dog while it is under heavy sedation or anesthesia. The PennHIP method measures passive laxity.
- Functional hip laxity is the pathologic form of laxity occurring during normal weightbearing in dogs with dysplastic hips. Current hip screening methods cannot assess functional hip laxity.

To see how PennHIP measures passive hip laxity, go to the Distraction Index - Measuring Laxity section.
For an in-depth discussion of the association between laxity and OA, go to the Laxity and Osteoarthritis section.

Effects of Functional Laxity on Joint Mechanics

Under normal conditions, the sum of the forces on the joint are spread out over a large surface area. When laxity is present in the joint, the force applied by the surrounding muscles actually increases to compensate for the laxity. The sum of the forces exerted on the dysplastic hip is greater than that the sum of the forces exerted on the normal hip. In addition, the forces on the dysplastic hip are applied over a smaller surface area. The high joint contact stresses produce injury and ultimately result in the loss of delicate articular cartilage. Over time, functional hip laxity results in erosion of the femoral head and flattening of the acetabulum.
Osteoarthritis (OA): The Big Picture

- OA causes pain and disability.
- OA affects all components of the synovial joint.
- There is no cure for OA.
- There are treatment options for OA.
  - Non-surgical treatments include use of NSAIDS and nutraceuticals, the modification of nutrition, increase exercise, and physical therapy.
  - Surgery is also an option for end stage disease (ex., FHO, THR).
- Prevention is key in the fight against canine hip dysplasia (CHD) and OA:
  - Accurate prediction of OA requires a reliable screening method implemented early in life.
  - Genetic control and selective breeding are substantiated effective means of reducing the severity of CHD and the development of OA in subsequent generations of animals.
- Environmental factors such as diet, activity level, and pharmaceuticals can influence the onset of OA.
- Surgery is also an option (ex., TPO, JPS). However, the safety and efficacy of preventative surgical procedures have not yet been studied adequately.
The Risk of Developing Osteoarthritis

For over 60 years, it has been empirically accepted that hip joint laxity is related to the development of osteoarthritis (OA) or degenerative joint disease (DJD). However, prior to the research conducted at the University of Pennsylvania, there existed little or no scientific evidence to support this view. The problem was approached in two ways: First, the relationship of hip joint laxity with the coexistence of OA in a cross-section of adult dogs was examined (cross-sectional study). Next, the relationship of laxity at an early age with the appearance of OA at a later time was investigated (longitudinal study). The results are summarized below.

Cross-sectional Study

An analysis of 142 dogs (mean age of 20 months) showed a direct relationship of hip laxity (as determined by the DI) to the radiographic existence of OA. Hips with low DI's, i.e. "tight hips", were very unlikely to exhibit OA. In this study only one hip with a DI less than 0.30 exhibited any evidence of OA (DI = 0.29). The converse was not true; that is, not all hips with a DI greater than 0.30 necessarily showed radiographic evidence of OA. However, as the DI increased, so did the frequency of OA. (see the graph below).

Distribution of the Distraction Index in 142 Dogs

It is interesting to note that more than 50% of the hips in this study had distraction indices below 0.30, yet only one hip in this group < 0.30 showed any radiographic evidence of OA. There appears to be a cut-off point - DI approximately 0.30 - below which the canine hips is not susceptible to getting OA.

Longitudinal Study

In this study, dogs were radiographed at 4 months, 12 months, 24 months of age. A logistic regression model was invoked to determine the contribution of factors such as DI, Norberg Angle (NA), subjective score (OFA), weight and gender at 4, 12 or 24 months to the risk of developing OA at or before 3 years. The analysis indicated that the DI at all age groups was the most significant prognostic factor and that the strength of the predictive power improved with age. The sex, weight, NA and subjective (OFA) score were not found to be significant factors in this study.
The PennHIP Program is wholly-owned by Antech Diagnostics, Inc. The PennHIP Program has no affiliation with The University of Pennsylvania.
What is PennHIP?

PennHIP Hip Improvement Program

What is PennHIP?

PennHIP is a multifaceted radiographic screening method for hip evaluation. The technique assesses the quality of the canine hip and quantitatively measures canine hip joint laxity. The PennHIP method of evaluation is more accurate than the current standard in its ability to predict the onset of osteoarthritis (OA). Osteoarthritis, also known as degenerative joint disease (DJD), is the hallmark of hip dysplasia (HD).

PennHIP is more than just a radiographic technique. It is also a network of veterinarians trained to perform the PennHIP methodology properly and, perhaps most importantly, it is a large scientific database that houses the PennHIP data. Radiographs are made by certified PennHIP members worldwide and are sent to the PennHIP Analysis Center for evaluation. The resulting data is stored in the database, which is continually monitored as it expands. As more information becomes available, the PennHIP laboratory is able to obtain more precise answers to questions about the etiology, prediction and genetic basis of hip dysplasia.

PennHIP publishes its findings in scientific journals. Published information is disseminated to all PennHIP members; it is also shared with interested breed clubs and routinely appears in publications within the dog fancy.

PennHIP is composed of three major components:

- A diagnostic radiographic technique
- A network of trained veterinarians
- A medical database for scientific analysis

PennHIP at a Glance

The PennHIP method is a novel way to assess, measure and interpret hip joint laxity. It consists of three separate radiographs: the distraction view, the compression view and the hip-extended view. The distraction view and compression view are used to obtain accurate and precise measurements of joint laxity and congruity. The hip-extended view is used to obtain supplementary information regarding the existence of osteoarthritis (OA) of the hip joint. (The hip-extended view is the conventional radiographic view used to evaluate the integrity of the canine hip joint.) The PennHIP technique is more accurate than the current standard, and it has been shown to be a better predictor for the onset of OA.

The radiographs pictured here are of the same dog, yet the hip joint laxties in each view look very different. Notice that the hips in the distraction view appear to be much looser than they do in the hip-extended view.

The obvious contrast in joint laxity between the distraction and hip-extended views demonstrates the fundamental difference between the two radiographs. The looser the joint on the distraction view, the greater is the chance that the hip will develop OA. The hip-extended view tends to mask true hip joint laxity because the joint capsule is wound up into a tightened orientation when the hips are extended. This explains why measurable joint laxity on the distraction view is always greater than the measurable laxity from the hip-extended view. In fact, distraction laxity is up to 11 times greater depending on the breed of dog under study.
The compression view is used to determine the "goodness of fit" of the femoral heads into the acetabula. In a hip with OA, the remodeling that occurs in the acetabulum and/or the femoral head, will often result in an ill-fitting "ball" and "socket".

To summarize, PennHIP method:
- Obtains OA readings from the standard hip-extended view
- Obtains hip joint congruity readings from the compression view
- Obtains quantitative measurements of hip joint laxity from the distraction view

A Brief History

In 1983, Dr. Gail Smith conceived and developed a new scientific method for the early diagnosis of CHD while at the University of Pennsylvania School of Veterinary Medicine. Research conducted in his laboratory proved the diagnostic method to be capable of estimating the susceptibility for CHD in dogs as young as sixteen weeks of age. In 1993, Dr. Smith established PennHIP, a cooperative scientific initiative, to serve as a multi-center clinical trial of the new hip dysplasia diagnostic technology. PennHIP has recently been acquired by Antech Diagnostics, Inc.
PennHIP Method > Distraction Index - Measuring Laxity

Measuring Hip Joint Laxity

PennHIP uses a unique method, an index, to measure hip joint laxity. The method is quantitative (i.e., it assigns a number to joint laxity) as opposed to being qualitative or subjective (e.g. excellent, good, fair, etc.). The index is not as vulnerable to inter- and intra-observer errors commonly associated with subjective measurement systems.

The index method is calculated by superimposing precision-machined circle gauges on the cortical margins (rims) of the acetabulum and femoral heads (see example at left) to find the respective geometric centers. On the compression view, if the joint is free of osteoarthritis, the centers of the acetabulum and femoral head should coincide indicating that the joint is indeed concentric. On the distraction view, the distractive force causes separation between the centers. The distance, \( d \), between the centers is a measure of hip joint laxity. However, \( d \) also varies with dog size (larger dogs would likely have larger \( d \)'s than smaller dogs), with age of the dog, and with magnification due to variation in hip-to-film distance. To circumvent these potential sources of variation, \( d \) is normalized with respect to all sizes of femoral heads and acetabula by dividing it by the radius of the femoral head, \( r \). The resulting index, \( I = \frac{d}{r} \), is a unitless number ranging from 0 to 1 (or more). The laxity index computed for the compression view is called a compression index (CI), likewise, the laxity index for the distraction view is called the distraction index (DI).

The distraction index is a measurement of hip joint laxity. It does not allude to a passing or failing score. Hips with DIs on the distraction view that are close to 0 are considered to be tight, while DIs close to 1 are considered to be very loose. The DI is an indication of the "percent out of joint" that the femoral head is displaced from the acetabulum. For example, DI=0.58 means the femoral head comes out of the joint by 58%, DI=0.75, 75% out of joint (see image at right), and so on. This also makes interpretation of the DI more intuitive: a hip with a DI=0.50 is twice as lax as a hip with a DI=0.25.

To obtain proper diagnostic radiographs, the musculature around the hip must be completely relaxed and so the dog must be under deep sedation or general anesthesia. Therefore, the laxity as determined by the DI is called passive hip laxity, as opposed to functional hip laxity which is the pathological form of hip laxity that occurs in dysplastic hips during weight bearing. (Clearly, functional hip laxity is of greater diagnostic interest, but there are presently no means to measure it.)
What is Cavitation?

If you’ve ever cracked your knuckles, you’ve created cavitation. This phenomenon can occur infrequently during the distraction procedure. As the distractor device imposes a lateral distractive force on the hips, the creation of negative pressure can cause a void to form in the synovial fluid in the joint. This void appears as an air bubble on the radiograph. Cavitation is not painful and does not cause short or long term damage to the joint. It occurs infrequently, and resolves within 24 hours.

Cavitation is problematic only because it causes the DI measurement to be unreliable. A cavitated joint can have a false increase in the DI.

Frequency of Cavitation

<table>
<thead>
<tr>
<th>Hip</th>
<th>N</th>
<th>%</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Either</td>
<td>279</td>
<td>4.2</td>
<td>3.7 - 4.7</td>
</tr>
<tr>
<td>Right</td>
<td>145</td>
<td>2.2</td>
<td>1.8 - 2.6</td>
</tr>
<tr>
<td>Left</td>
<td>156</td>
<td>2.3</td>
<td>2.0 - 2.7</td>
</tr>
<tr>
<td>Both</td>
<td>18</td>
<td>0.27</td>
<td>0.17 - 0.44</td>
</tr>
</tbody>
</table>

LaFond E, Smith GK, Gregor TP, JAVMA,1997;210:1294-1297

Cavitation occurs unilaterally 4.2% of the time and bilaterally 0.27% of the time. The frequency of occurrence is about the same for either hip; occurring 2.2% of the time in the right hip and 2.3% of the time in the left hip.

Cavitation on the Radiograph

The appearance of cavitation on a radiograph may be unilateral (one hip), or bilateral (both hips). The cavitation void appears as a dark bubble on the radiograph (see arrow).

If cavitation is unilateral

- No DI will be generated for the cavitated hip.
- An interpretation will be derived from the non-cavitated hip.

If cavitation is bilateral

- No DI will be generated for either hip.
- It is recommended that the evaluation be repeated in 24 hours.
Frequently Asked Questions

Here are a few of the most frequently asked questions about the PennHIP method. The answers to these questions may raise additional questions. For more detailed answers, please explore the relevant areas of this web site.

General Information

Why use PennHIP?

Answer:

A growing body of scientific information from multiple independent laboratories confirms that the PennHIP method surpasses other diagnostic methods in its ability to measure hip joint laxity and accurately predict the onset of DJD. The PennHIP method can be performed on dogs as young as sixteen weeks of age compared with two years using the standard technique. The data generated by PennHIP allows breeders to confidently identify the members of their breeding stock with the tightest hips and the best breeding potential. Pet owners are able to obtain an estimate of their dog's risk for developing DJD and, if necessary, make lifestyle adjustments for their dog to enhance the quality of their pet's life. The PennHIP interpretation will also permit breeders to assess the progress they are making with their breeding program.

PennHIP is performed only by certified individuals who have undergone training and have successfully demonstrated their expertise in performing the technique. In addition to the special radiographs developed by PennHIP, the method also incorporates the standard hip-extended view into the interpretation of hip joint integrity. Upon request, your PennHIP veterinarian can make a copy of the hip-extended radiograph for submission to the OFA at the time your dog has PennHIP radiography. You do not have to abandon the OFA view or schedule a separate appointment to have it done.

What is the rationale behind PennHIP?

Answer:

Through a sophisticated biomechanical study, it was found that the hip is loosest when positioned in a neutral or "standing" orientation (also called the stance-phase of weight bearing). It was reasoned that this point is also the optimal patient position for measuring maximal hip joint laxity on a radiograph. Ironically, the standard hip-extended method was found to put the hip in one of its tightest configurations.

Next, passive hip laxity was radiographically monitored in dogs as they matured. It was shown that 1) the radiographic measurement of passive hip joint laxity by the PennHIP method was accurate in dogs as young as sixteen weeks of age, and 2) hip laxity was the primary risk-factor to predict the development of DJD. Specifically, the looser the hip joint according to the PennHIP method, the greater the chance that it will develop DJD.

The PennHIP method also incorporates the hip-extended radiograph to evaluate for evidence of DJD.

What is PennHIP?

Answer:

The PennhIP Hip Improvement Program is a service provided in conjunction with a worldwide network of over 2000 certified PennHIP-trained veterinarians from 24 countries. PennHIP’s primary objective is to reduce the frequency and severity of hip dysplasia in all breeds of dogs. PennHIP is attempting to accomplish this goal through the implementation and widespread utilization of a new stress-radiographic technique (X-ray). Through the network of certified veterinarians implementing this technique, PennHIP is amassing a large scientific database on the etiology (cause), prediction and genetic basis of canine hip dysplasia (CHD).

The PennHIP method is a different way to assess, measure and interpret hip joint status. It consists of three separate radiographs: the distraction view, the compression view and the hip-extended view. The distraction view and compression view, developed by Dr. Smith, are used to obtain accurate and precise measurements of hip joint laxity and congruity, respectively. The hip-extended view is used to obtain supplementary information regarding the existence of DJD in the hip joint.

To summarize, PennHIP is composed of three major components:

- A diagnostic radiographic technique
- A network of trained veterinarians
- A medical database for scientific analysis

How was PennHIP developed?

Answer:

In 1983, Dr. Gail Smith while at the University of Pennsylvania School of Veterinary Medicine began to research and develop a scientific method for the early diagnosis of CHD. Multiple scientific disciplines - including biomechanics, orthopedics, clinical medicine, radiology, epidemiology and population genetics - have been incorporated during the development of PennHIP. This research resulted in a diagnostic method capable of estimating the susceptibility for CHD in dogs as young as sixteen weeks of age.

In 1993, Dr. Smith established PennHIP, a cooperative scientific initiative, to serve as a multi-center clinical trial of the new hip dysplasia diagnostic technology.
Frequently Asked Questions

Information About the Procedure

What Happens to My Dog During a PennHIP Evaluation?

Answer:

To obtain diagnostic radiographs, it is important that the patient and the surrounding musculature be completely relaxed. For the comfort and safety of the animal, this requires sedation and/or general anesthesia. Typically, the procedure involves positioning the dog in a neutral orientation and using a special positioning device to apply a force to cause the hips to displace laterally. This position is the most accurate and sensitive for assessing the degree of passive hip laxity. Passive hip laxity has been shown to be the primary risk factor associated with the development of DJD. A hip-extended view is also included for the sole purpose of examining for existing joint disease such as osteoarthritis. The PennHIP procedure has been safely performed on thousands of patients.

How Old Must My Dog be to Have a PennHIP Radiograph?

Answer:

PennHIP has studied the efficacy of this method from the eight weeks up to three years of age. The PennHIP method can be reliably performed on a dog as young as 16 weeks old. Passive hip laxity at 16 weeks correlates highly with later hip laxity. In other words, a dog's hip laxity at 16 weeks will be much the same at one year, two years or even three years. The accuracy of laxity measurements for German Shepherd Dogs less than 16 weeks of age is not high enough to be of clinical use. Other breeds require study to determine the earliest reliable age of evaluation.

The looser the joint, as determined by the PennHIP method, the greater is the chance that the hip will develop DJD. (The standard hip-extended method can actually mask true hip joint laxity.) There are obvious advantages to screening dogs for hip joint laxity at 4 months of age (or six months, 1 year, etc.) as opposed to waiting until 2 years of age. The reliability of the PennHIP method slightly improves with age, with one year 1 year being marginally superior to 6 months, which in turn is marginally better than 4 months. For all dogs, we recommend that the earliest age of evaluation be no more than 16 weeks, so long as the dog is sufficiently sedated to obtain a diagnostic quality radiograph (and, of course, so long as the drugs and dosages used are safe).

Does This Procedure Require Sedation and/or Anesthesia?

Answer:

To obtain diagnostic quality radiographs, the musculature around the hip joint must be completely relaxed. For the comfort and safety of the animal, this requires either heavy sedation or general anesthesia. The selection of the individual sedation/anesthesia protocol is left to your PennHIP veterinarian's discretion, so long as the dog is sufficiently sedated to obtain a diagnostic quality radiograph (and, of course, so long as the drugs and dosages used are safe).

Is It Possible to Hurt My Dog's Hips?

Answer:

After many studies, both in the PennHIP laboratory and in independent laboratories, there is no evidence to suggest that the PennHIP procedure is any more harmful than the standard hip-extended procedure. Certainly, in dogs having extreme laxity and pain associated with hip dysplasia, any manipulation of the hip (e.g., OFA, PennHIP, routine physical examination) can potentially cause transient discomfort (1-2 days). PennHIP is aware of only a handful of cases (from over 20,000 dogs) that have exhibited discomfort after the procedure. All such claims are followed up and no long-term pain or untoward effects have been observed. The OFA has issued a statement to breed clubs suggesting that the PennHIP method harms hips. There is absolutely no basis to this claim.

Is the PennHIP Procedure More Expensive Than the OFA Procedure?

Answer:

The total fee for a PennHIP evaluation is determined by the veterinarian providing the service. It is important to remember that the total service includes sedation/anesthesia, 3 radiographs, office consultation and all charges associated with mailing and film evaluation. You will not find it necessary to write a separate check for evaluation fees or mailing of your dog's films. The film evaluation charge will be included in the total cost of a PennHIP evaluation.

Your PennHIP veterinarian will likely charge more for the analysis because it consists of 3 radiographs rather than one. (Also, he/she incurred costs of training, quality assurance testing and purchasing the necessary equipment.)

How Can I Get the Name of a PennHIP Veterinarian or Get Answers to Additional Questions?

Answer:

To obtain the name of a veterinarian in your area who is trained and certified to perform the PennHIP procedure, follow the link to find a certified PennHIP veterinarian. If there is not a veterinarian near you presently, additional veterinarians are currently being trained throughout the country.

Benefits and Other Items

How does PennHIP differ from evaluation methods which use the hip-extended position?

Answer:

PennHIP differs from other methods in some very fundamental and important ways:

Scientific Protocol

PennHIP was developed and tested following strict scientific protocol and the results of these studies have been, and continue to be, published in peer-reviewed scientific journals. More than a decade of research and analysis have produced a body of information in support of PennHIP's effectiveness. (As with all diagnostic tests, PennHIP's accuracy is not 100%, but in direct comparisons it is far superior to any other available diagnostic methods.) No other method, published or practiced, has similar compelling scientific support.
**Objective Assessment**

PennHIP's evaluation protocol quantitatively measures passive joint laxity. Based on the degree of laxity, the individual dog is ranked relative to other members of the same breed. This allows breeders to easily identify animals with tighter hips within each breed. Dogs with tighter hips are less likely to develop osteoarthritis (hip dysplasia). Note that the hip evaluation report is not issued in a subjective pass/fail framework. This approach was adopted because some breeds of dogs have few members with hips tight enough to be considered truly DJD non-susceptible. In such breeds, genetic progress can be made (while still maintaining adequate genetic diversity) simply by breeding dogs in the tighter half of the population. Of course, greater selection pressure equates to more rapid genetic change.

**Patient Positioning**

Because PennHIP is measuring maximal passive hip laxity, the position of the patient is very different from the hip-extended position. The legs are in a neutral or stance-phase position rather than the conventional hip-extended position. The hip-extended position has been used for more than 57 years to screen hips for either DJD, laxity or both. However, studies have indicated wide diagnostic variability among radiologists in interpreting this view. Further, through biomechanical testing, the hip-extended view was found to mask the underlying true joint laxity and through direct comparison, the predictive value for CHD was shown to be inferior to the PennHIP procedure.

**Heritability**

Heritability is an important statistic relating the variation of a trait attributable to additive genetic effects with the total phenotypic variation of the trait. In other words, heritability relates the genetic makeup of a disease or trait with what is actually expressed or observed outwardly. Heritability is expressed as a number between 0 and 1. The higher the heritability, the greater the rate of genetic change that can be derived from selection pressure. The accuracy of a diagnostic test to determine disease (in this case CHD), has profound impact on the value of the heritability statistic. Inaccuracy of a diagnostic test acts to lower the estimate of heritability.

The heritability of the diseased phenotype evaluated in the hip-extended view has not been studied in most breeds of dogs in the USA. PennHIP is working with many breed clubs with an interest in the heritability estimates for their particular breed. Estimates for the heritability of passive hip laxity (DI) drawn from analysis of full pedigrees for the breeds examined thus far have yielded high values (e.g. for German Shepherd Dogs, heritability = 0.48; Labrador retrievers, heritability = 0.80).

Estimates of heritability of the dysplastic phenotype subjectively scored from the conventional hip-extended radiograph are not available for most breeds of dogs in the USA. Only a few published reports in as many breeds of dogs exist worldwide. To our knowledge, the OFA has not published heritability estimates for the subjective OFA phenotype.

**Quality Control**

The PennHIP method is based on strict quality control. To take PennHIP radiographs, veterinarians must undergo a training and certification process to demonstrate competency. PennHIP films are critically evaluated and the veterinarians are asked to repeat the procedure if the films do not meet PennHIP's stringent standards. The data generated from PennHIP undergoes regular review and statistical analysis so that useful information, by breed, is available to judge progress toward reducing CHD.

**Mandatory Film Submission**

For optimal validity, it is mandatory that all hip radiographs by PennHIP veterinarians be submitted for analysis and inclusion in the PennHIP database. This policy eliminates the practice of "prescreening" radiographs and sending only the best hips for evaluation. This "prescreening" practice has been shown to result in a biased database containing a greater frequency of non-diseased hips than actually exists in the true population. Excluding the worst hips leads to a false impression that genetic progress is being made.

**Will AKC and Other Breed Registration Organizations "Recognize" PennHIP?**

**Answer:**

In 1996, the AKC board of directors announced plans to remove all health and genetic information from the official AKC registration and to include it along with PennHIP information in the newly conceived "Information and Health Database." We have recently learned (July 1998) that the AKC plans to re-energize this initiative. We anxiously await progress from the AKC on this very important issue. Meanwhile, we are currently working with other organizations, nationally and internationally to present the PennHIP technology and the positive impact it holds for reducing Canine Hip Dysplasia. The PennHIP method has been adopted by several countries and is gaining wide spread interest internationally.

**How Can I Get the Name of a PennHIP Veterinarian or Get Answers to Additional Questions?**

**Answer:**

To obtain the name of a veterinarian in your area who is trained and certified to perform the PennHIP procedure, follow the link to find a certified PennHIP veterinarian. If there is not a veterinarian near you presently, additional veterinarians are currently being trained throughout the country.

**My vet has advised a surgical procedure to avoid the development of arthritis in my dog later in life based on the results of his PennHIP examination. Should I have my dog operated on?**

**Answer:**

Until appropriate randomized and controlled clinical trials are designed and conducted, it is premature to use the Distraction Index as an indication for hip surgery, either remedial or preventive. At present several different surgical procedures (Triple pelvic osteotomy, Juvenile symphysiodesis) have been advocated by some veterinary surgeons to prevent the development of arthritis (degenerative joint disease) later in life in dogs with excess joint laxity (loose hips). None of these procedures have undergone scientific clinical trials that have proven THEIR EFFICACY in preventing the onset or slowing the development of arthritis in dogs with hip dysplasia. Although WE ARE not fundamentally against the use of preventative surgical management of dogs with excessive hip laxity, WE FEEL THE WHOLESALE CLINICAL USE OF PURPORTEDLY PREVENTIVE SURGICAL PROCÉDURES BEFORE ADEQUATE TESTING IS CONDUCTED, IS UNJUSTIFIED. WE ADVISE CAUTION! It may be that in the future when good evidence exists to support the efficacy of these

http://info.antechnimagingsservices.com/pennhip/navigation/general/frequently-asked-questions.html
How Does This Benefit Me as an Owner or Breeder of Dogs?

Answer:

Researchers have been able to demonstrate that the PennHIP method surpasses other diagnostic methods in its ability to accurately predict susceptibility to developing DJD. This finding has been corroborated recently by an independent laboratory. The PennHIP method can be performed on dogs as young as sixteen weeks of age compared with two years using the standard technique. The ability to receive an early estimate of a dog's hip integrity is important whether the dog's intended purpose will be for breeding, for working or as a family pet. The data amassed and analyzed by PennHIP will allow breeders to confidently identify the members of their breeding stock with the tightest hips. The PennHIP evaluation will also permit breeders to assess the progress they are making with their breeding program as they strive to reduce the amount of hip laxity in their dogs. Pet owners are able to assess their pet's risk of developing DJD. This enables them to make lifestyle adjustments for their dogs and, if necessary, to enhance the quality of their pet's life.
The female heat cycle (estrus) and hip screening

Since the 1960’s it has been believed that increased estrogen levels during the female heat cycle will affect hip joint conformation by making them appear falsely lax (looser).

In 1997, researchers at the University of Pennsylvania decided to test this theory and followed 9 bitches through an entire cycle. During the study vaginal cytology, behavioral signs and physical exam findings were used to identify the different stages of the cycle. Blood samples were obtained during each estrus-phase, from which hormone concentrations were measured, specifically oestradiol-17β and progesterone. Hip x-rays were taken using the OFA view (hip-extended view) and the PennHIP radiographs during each phase of the heat cycle.

Results showed that even though the hormone levels fluctuated (as expected) the PennHIP DI (hip laxity) and the OFA-type scores did not change significantly.

In Short: The rise in hormone levels during the female heat cycle does not affect hip laxity as measured by PennHIP. However, hormones released during the birthing process (relaxin) and during lactation (prolactin) however, can increase hip laxity and hip evaluation at this time is therefore not recommended. PennHIP recommends waiting 8 weeks post lactation or 16 weeks post whelping, before a PennHIP evaluation.
PennHIP has published more than 40 manuscripts over the past 20 years. PennHIP receives many questions each day regarding different areas of the PennHIP method. Often, the published literature contains the answers, but the manuscripts may be difficult to access and written in scientific language that can overwhelm readers or hide salient points of the research. Some of the important features of the PennHIP method are included below with a brief synopsis of the literature available. Links to the abstracts for these studies have been included if you wish to read into them further!

1. The Distraction Index (DI) as determined by the PennHIP method is the most reliable indicator of future hip osteoarthritis.

In a study comparing factors such as age, breed, weight, gender, distraction index and Norberg angle (another method of measuring hip laxity based on the conventional OFA-type x-ray), it was found that the distraction index was the most significantly correlated with future development of osteoarthritis irrespective of age at the time of PennHIP evaluation.


Abstract

2. The distraction index does not change significantly over time.

A study of large breed dogs showed that the distraction index stayed the same over time (within acceptable statistical limits) and was much more reliable over time than other methods such as the Norberg angle and the OFA scoring method.


Abstract

3. Keeping your dog at a lean weight throughout life delays the onset of hip osteoarthritis related to hip dysplasia.

Restricted feeding to maintain a lean body condition delayed or prevented development of radiographic (x-ray) signs of hip joint osteoarthritis in a group of 48 Labrador Retrievers followed throughout life. Lifetime maintenance of 25% diet restriction delayed onset and reduced severity of hip joint osteoarthritis, thus favorably affecting both length and quality of life. This study also showed that hip osteoarthritis can develop at anytime throughout a dog’s life.


Abstract

4. The PennHIP method can be reliably performed on a dog as young as 16 weeks old.

PennHIP has studied the efficacy of this method from eight weeks up to three years of age. For the present, it is recommended that dogs should not be evaluated before 16 weeks of age and that follow-up radiography at 6 months or 1 year of age is encouraged. However, the decision to have the method performed again is always that of the owner.

Smith GK, Gregor TP, Rhodes WH and Biery DN. Coxofemoral joint laxity from distraction radiography and its contemporaneous and prospective correlation with laxity, subjective score and evidence of degenerative joint disease from conventional hip-extended radiography, *Am J...*
5. **80% of dogs evaluated as “normal” by the OFA were found to have hip laxity by PennHIP testing that predisposed them to developing hip osteoarthritis in the future.**

Dogs judged as normal by the OFA harbored clinically important passive hip joint laxity as determined via the PennHIP distraction index. Results suggested that OFA scoring radiographs (x-rays) underestimated susceptibility to osteoarthritis in dogs. The presence of these “normal” dogs in the breeding pool may slow the progress of decreasing hip dysplasia prevalence.


**Abstract**

6. **PennHIP Biomechanics**

Biomechanical testing determined the optimal patient position for measuring hip laxity. Hip laxity was found to be maximal in the non weight-bearing position used in the PennHIP method and is actually masked in the conventional hip-extended position.


**Abstract**


**Abstract**

7. **PennHIP continues to research inherent differences among breeds.**

The breeds with the tightest hips as measured by DI have the lowest susceptibility to showing hip osteoarthritis. Within each of the 8 breeds (American bulldog, Bernese Mountain Dog, German Shepherd dog, Golden Retriever, Labrador Retriever, Newfoundland, Rottweiler, and Standard Poodle) studied thus far, the looser the hips, the greater the likelihood of showing hip osteoarthritis.


**Abstract**


**Abstract**

8. **Hormonal effects on hip dysplasia**

Contrary to popular belief, estrus (being in heat) is of no consequence to hip scoring; the study performed showed definitively that estrus does not adversely affect the distraction index or any other hip scoring method. The hormone relaxin, however, remains present up to 8 weeks post whelping (although it varies by breed). We know of no study describing whether relaxin has any effect on DI or any other hip scoring method but to be on the safe side, we advise waiting 8 weeks post-lactation or 16 weeks post-whelping.


9. **Within and Between Examiner Repeatability**

Studies have shown that the PennHIP method has a very high degree of reproducibility between examiners. In other words, your dog should have similar distraction scores no matter which PennHIP certified veterinarian performs the radiographs. This high degree of consistency is attributable to the inherent
The PennHIP Program is wholly-owned by Antech Diagnostics, Inc. The PennHIP Program has no affiliation with The University of Pennsylvania.

10. **Cats and Hip Dysplasia**

Did you know cats can get hip dysplasia? As in dogs, the distraction index is correlated with osteoarthritis; the greater the distraction index, the more likely a cat will develop osteoarthritis. However, further studies need be conducted to determine how well cats tolerate laxity. As of June 2011, 131 cats are listed in the PennHIP database.


Abstract


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Abstract


Abstract
Selective Breeding

Selection Pressure in Breeding

The principal objective of selective breeding is to maximize the pairing of good genes by breeding dogs not affected with (and preferably, not susceptible to) CHD.

For the most rapid genetic change, the breeder can decide to mate only the tightest-hipped dogs within the breed (those with the lowest DI) and then continue to inbreed for tight hips from there. This approach, however, will create increased inbreeding. Founding a breeding program on only a few dogs, and inbreeding on these dogs, would reduce the overall genetic diversity in the gene pool and could contribute to the loss of some desirable traits or lead to the expression of some undesirable traits. This reality affects some breeds more than others. For example less than 5% of Golden Retrievers have hip laxity in the ‘tight-hipped’ range, meaning a DI below 0.30. If one were to require that breeding candidates conform to this standard, 95% of the Golden Retrievers would be excluded from breeding, resulting in a serious reduction in genetic diversity. This breeding strategy would neither be practical nor acceptable to breeders and is not recommended by PennHIP.

To avoid these potential problems accompanying ‘extreme’ selection, PennHIP suggests a more ‘moderate’ approach which goes hand in hand with the PennHIP testing. Particularly in breeds with few or no members having tight (OA-unsusceptible) hips this moderate approach is preferable. In such breeds it is recommended that breeders choose breeding stock from the tightest 40% of the breed (meaning the 60th percentile or better), thereby maintaining an acceptable level of genetic diversity while still applying meaningful selection pressure. By breeding only dogs with hips above the breed average (60th percentile or better) the overall breed average will move toward better (tighter) hips from one generation to the next. Clearly the more selection pressure applied (stricter selection criteria), the more rapid the genetic change.

The PennHIP database ranks each dog relative to other members of the breed making it possible for the breeder to identify dogs whose DI will apply meaningful selection pressure. By applying at least moderate selection pressure, eventually the average of the population will shift with each generation toward tighter hips, increasingly tightening the minimum standard for breeding. By following these time-tested principles of quantitative genetics, ultimately fewer dogs will be at risk for developing OA. Understandably, more rapid genetic change could be achieved by imposing greater selection pressure or by using estimates of breeding value (EBV) from incorporation of the pedigree. These strategies are recommended for the aggressive breeder wishing to achieve the most rapid hip improvement.