

X-ray Positioning in OFA Hip Dysplasia Grading: The Devil is in the Details

By Lonnie L. Davis, DVM, DABVP (Canine/Feline)
With Nancy P. Melone, Ph.D.

Abstract.

Hip dysplasia, a debilitating orthopedic disease, affects many breeds, particularly large and giant breeds. Consequently, hip grading and hip certification of purebred dogs has become increasingly important to breeders, pet owners, and veterinarians alike in efforts to reduce the disease. A correct diagnosis of hip dysplasia is essential when a breeder evaluates breeding stock, a veterinarian advises dog owners, or a pet owner considers treatments and therapies for the family dog. This article discusses the detrimental impact that an incorrectly positioned X-ray can have on the accurate diagnosis of hip dysplasia or hip grading and certification. The case is explored empirically in a study of 200 dogs initially submitted to OFA for hip grading and then resubmitted to OFA after follow-up X-rays were taken using the Precise Positioning Technique® developed by the first author. These data show the importance of correct positioning in capturing the true anatomical structure of the dog on the X-ray for the purpose of accurately identifying canine hip dysplasia.

Breeders make substantial reputational, emotional, and financial investments in the dogs associated with their breeding programs. Campaigning an outstanding show dog over a period of time to develop a reputation can cost well over \$250,000. Providing quality veterinary care for brood bitches, stud dogs, and their litters also carries a hefty price tag. Layered on top of this are the costs associated with finding the right stud dog, collecting and shipping semen, progesterone testing for the bitch to ensure precise timing for insemination, and the occasional emergency C-section.

Like responsible breeders, responsible pet owners also make emotional and financial investments in their pets. Pet owners depend on their breeders to look out for their interests as careful stewards of the breed. At the top of the pet owner's list of desires is that their pet be healthy and free of debilitating disease or defects that might shorten or compromise the pet's life. Similarly, pet owners rely on their veterinarian to recognize, correctly diagnose, and if need be help them monitor and manage the disease.

Obviously, not all breeds confront the same health issues; therefore different breeds require different tests depending on the prevalence of disease or defect in the breed and the existence and quality of tests for those diseases or defects. Indeed, an entire industry has grown up around the development of canine health tests, the analysis of test results, and the certification of health status based on the evaluation of test outcomes. Hip dysplasia affects many breeds, particularly the large and giant breeds. Hence, hip grading and hip certification of purebred dogs has become increasingly

important to breeders and veterinarians over the last 40 years in their efforts to reduce the incidence of the disease.¹

Canine Hip Registries in the US

There are two recognized authorities in the US for evaluating canine hip dysplasia. The Orthopedic Foundation for Animals (OFA), the oldest authority in the US, is recognized both nationally and internationally. More recently, PennHIP, now associated with Antech, also has developed a method for evaluating hip dysplasia. While the approaches used by these two organizations differ, both have similar goals (evaluate hip dysplasia), and both rely on radiographs as inputs into their evaluation processes. In both cases, the quality of the radiograph plays a major role in determining the accuracy of the evaluation. In this paper, we focus only on processes and methods used by OFA.

In existence for over 40 years, OFA is recognized as the final judgment for most official breeds on whether a dog is free from hip dysplasia and is therefore a candidate for breeding or whether the dog has hip dysplasia and the breeder should consider removing it from their breeding program. Dogs with hips determined to be free of hip dysplasia can receive OFA grades of “excellent,” “good,” or “fair”; it is from this group of passing dogs that most breed clubs recommend selecting breeding bitches or stud dogs. PennHIP provides a numerical sliding scale comparing dogs of the same breed.

Unfortunately, not all dogs are free from hip dysplasia. For those dogs showing evidence of hip dysplasia, such as remodeling of the femoral head or neck, the grades given by OFA will vary depending on the severity of the disorder. Failing OFA grades include “borderline,” “mild,” “moderate,” and “severe” dysplasia. The mode of inheritance for hip dysplasia is not known but thought to be polygenic (*i.e.*, involving multiple genes), and so the recommendation for dogs with failing grades is drastic. Dysplastic dogs should be removed from breeding programs to avoid passing the disorder on to future generations, however it is passed.

Ensuring Accurate Diagnosis and Grading of Hip Dysplasia

Because orthopedic disease and defects can marginalize a dog’s quality of life, breeders, pet owners, and veterinarians have a stake in ensuring the integrity of the tools and processes used to diagnose and reduce its frequency. While there are many ways in which integrity can be compromised, the major areas where problems can occur are at the points of (1) capturing the anatomical structure of the hip as a radiographic image and (2) evaluating that image for the purpose of diagnosis or awarding or rejecting certification. This paper focuses primarily on the former

¹ Hou, Y., Wang, Y., Lu, X., Zhang, X., Zhao, Q., Todhunter, R.J., Zhang, Z., *Monitoring Hip and Elbow Dysplasia Achieved Modest Genetic Improvement of 74 Dog Breeds over 40 Years in USA. PLOS ONE* (www.plosoone.org), October 2013 (8:10) e76390.

(image capture), particularly on the importance of correct positioning in capturing the true anatomical structure of the dog on the radiograph for the purpose of identifying canine hip dysplasia. An OFA radiologist who receives a poor quality X-ray from a veterinarian has two options: attempt to read the X-ray anyway or reject it. Indeed, OFA rejects some of the X-rays it receives from veterinarians. Both processes (image capture and image evaluation) require the skills of veterinarians and radiologists with significant experience and expertise and an eye for detail. Where such skill at either stage is not present, the results can lead to errors in the identification of hip dysplasia and the failure to obtain certification on a valuable animal.

The Dilemma of the Failing Hip Grades

Observation over 40 years of performing up to 400 hip radiographs annually revealed an interesting dilemma. Breeders and owners who were referred to the first author's practice reported that their dogs had received failing OFA hip grades, yet the dogs showed no signs or symptoms of dysplasia, and their lines had no history of the disorder. These breeders were distraught and at a loss to understand why their dogs were failing.

To better understand the underlying causes for these failures, the practice took new radiographs of some of these failed dogs and submitted them again to OFA. This time the majority of these previously failed dogs received passing hip grades. How could the same dog go from being dysplastic to passing? To the extent a dog's hip grade would change over time, the normal expectation is that the hip grade would become worse rather than better. That was clearly not what was happening. What could explain the improvement in hip grades?

If one questions the likelihood of the true anatomy of hips going from failing (dysplastic) to passing, there is only one plausible explanation for these results—an error in image capture or in image evaluation. Because image capture is the input into the image evaluation process, it is logical to focus there first.

Positioning of the Dog to Produce an Anatomically True Hip Image

An accurate assessment of hip conformation begins with correct positioning of the dog so that the image captured for evaluation is that of the dog's true hip anatomy. Errors in hip grading can occur easily if positioning is not done correctly. For that reason, OFA is quite specific on what is required of the veterinary staff taking the radiographs:

In this standard hip extended position (ventrodorsal view), the animal is placed on its back with the pelvis symmetrical, both femurs extended and parallel, and with the stifles (knees) rotated internally placing the patellas (knee caps) on the midline. The radiograph should include the last two lumbar vertebra and

the stifle joints. It is essential, particularly in marginal cases, to obtain proper position and radiographic technique.²

This ventrodorsal position is endorsed by the American Veterinary Medical Association and the American Animal Hospital Association.

While the description seems straightforward, the rounded anatomy of the dog's back complicates the process. Unlike human beings, who have a relatively flat back that can be placed symmetrically and stably on an X-ray table, the dog's back tends to roll to one side or the other, causing it to move out of symmetry. While the dog may appear visually on the table to be symmetric, a review of the radiograph taken in that position may indicate that the dog was not correctly positioned. The only way to tell that the dog is symmetrically positioned on the table is to look at the actual X-ray. Often this requires taking more than one X-ray. Figure 1 shows a hip radiograph that is relatively close to correct symmetric positioning. The dog whose hips are depicted in this radiograph received an OFA "excellent" hip score.



Figure 1: Example of close-to-symmetric positioning of hips on radiograph submitted to OFA and graded "excellent"

² Keller, G., *The Use of Health Databases and Selective Breeding: A Guide for Dog and Cat Breeders and Owners* (5th Edition). Columbia, MO: Orthopedic Foundation for Animals, 2006, pp. 16-17.

Research on how people become experts suggests that a veterinarian who takes many of these hip X-rays (*e.g.*, more than 100 per year) is more likely to do a better job of recognizing an asymmetric radiograph that should be retaken over someone who takes only a few hip X-rays per year. Experience with specific breeds might be useful as well. A caveat worth noting is while expertise is virtually impossible to acquire without considerable practice, practice alone does not always produce an

expert.³ These notions on expertise also apply in grading and evaluation of X-rays, but that is not the topic of this paper.⁴

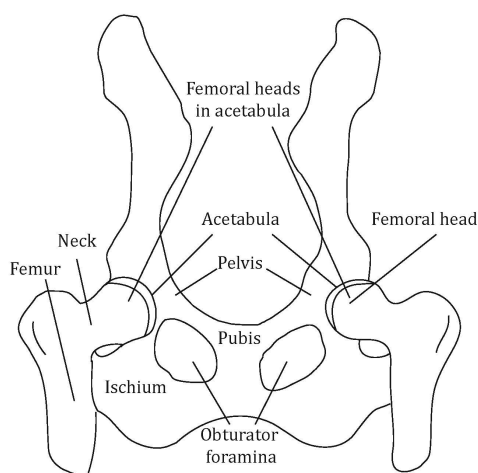


Figure 2: Canine hip anatomy

Recognizing Incorrect Positioning

Correct positioning of the dog during X-rays is important in obtaining an accurate evaluation of the hip joint. Figure 2 illustrates the various anatomical elements involved in evaluating the joint for hip dysplasia. The normal hip socket should look on X-ray like a tightly curved letter “C” that curves over the femoral head (ball of the hip). A shallow hip socket looks more like a parenthesis (*i.e.*, showing less curve). When the pelvis of a dog with normal hips is not parallel with the X-ray table, the resulting X-ray can yield an inaccurate evaluation and make it appear that the dog has subluxation in

one or both hip joints when it does not. In layperson’s terms, an X-ray in which the left hip and right hip are at *different* heights from the X-ray table (*i.e.*, they are not equidistant from the surface of the X-ray table) can make it appear that the femoral head (ball) of the hip joint is not seated deeply enough in the acetabulum (hip socket) on one or both sides of the hip. This incorrectly tilted pelvis can also create the appearance of an acetabulum (socket) that is too shallow. Ideally, if the dog is positioned levelly on the table, the obturator foramina, the two large openings created by the ischium and pubis bones of the pelvis, seen on both sides of the spine, are roughly symmetric (*i.e.*, both openings are of equal size and shape). In addition, the femurs (thigh bones) should be roughly parallel with each other.

³ Lesgold A.M. *Acquiring Expertise*. In: Anderson J.R., Kosslyn S.M., eds. *Tutorials in Learning and Memory: Essays in Honor of Gordon Bower*. San Francisco, CA: Freeman, 1984, pp. 31-60.

⁴ Lesgold A., Rubinson H., Feltovich P., Glaser R., Klopfer D., Wang Y. *Expertise in a Complex Skill: Diagnosing X-ray Pictures*. In: Chi M.T.H., Glaser R., Farr M.J., eds. *The Nature of Expertise*. Hillsdale, NJ: Erlbaum, 1988, pp. 311-341.

One should not carry false hope regarding the power of correct positioning if a dog is truly dysplastic. If a dog has remodeling of the femoral head, remodeling of the femoral neck (the bone connecting the ball to the femur or thigh) or osteophytes (arthritic calcium deposits), the dog is dysplastic, and no amount of positioning or repositioning will suggest otherwise.

In contrast, the question being asked here is: did the dog fail ONLY because of subluxation and/or shallow acetabula? If a dog fails on either or both of these defects, one should re-evaluate the position of the dog in the original X-ray closely to see if this could be an incorrect interpretation that resulted from poor positioning. An example illustrates the point.

The two X-rays in Figures 3a and 3b show a comparison of the same dog (as verified by microchip). The first image (Figure 3a) is that of the digital X-ray originally submitted to OFA by the other veterinarian and provided to the dog's owner. The second image (Figure 3b) is a new film of the same dog taken by the first author using the Precise Positioning Technique®⁵ and subsequently submitted to OFA. Both films were accepted and read by OFA and issued official grades. Compare these X-rays with the OFA guidelines.



Figure 3a:
Original X-ray (by another clinic) graded
by OFA as “mildly dysplastic” (failed)



Figure 3b:
Second (retaken) X-ray of same dog in
Figure 3a submitted and regraded by OFA
as “good” (passed)

⁵ Davis, Lonnie. *The Importance of Precise Positioning to Obtain an Accurate OFA Evaluation*. Lakewood, CO: American Animal Hospital Association, 2012. DVD.

An Empirical Study of the Impact of Incorrect Positioning on OFA Hip Grades

Data and Method

Two hundred purebred dogs of various breeds participated in the study. Radiographic and OFA grade data were collected for each dog over a period from June 14, 2010, to May 24, 2014. All dogs in the study had had previous X-rays submitted, accepted and graded by OFA. Of the 200 dogs in this study, 163 had previously received non-passing grades of “borderline,” “mild hip dysplasia,” or “moderate hip dysplasia”; 35 had received a passing grade of “fair”; and 2 had received grades of “good.” For each of the 200 dogs new follow-up X-rays using the Precise Positioning Technique® developed by the first author were taken. The new X-rays were subsequently submitted to, accepted, and graded by OFA.

Results

The results of the study for dogs previously receiving *failing* hip grades (severe, moderate, mild, or borderline) are shown in Table 1. The numbers and percentages in Table 1 in the white cells indicate instances in which there were *no hip grade changes* from the previous X-ray to the new X-ray using the Precise Positioning Technique®; those in gray cells indicate the instances in which there were *improvements in hip grades*; and those in the black cells indicate instances in which *hip grades worsened*.

Of the 163 who had previously failed (*i.e.*, were diagnosed as dysplastic) based on the original X-rays, 104 (63.8%) of these previously failed dogs went on to receive *passing* OFA hip grades based the new X-rays taken with Precise Positioning Technique®.

The results for dogs previously receiving *passing* hip grades (fair or good) are also shown in Table 1. Focusing on the 35 X-rays of dogs that previously passed receiving grades of “fair,” 31 (88.5%) of these X-rays received *improved* OFA grades (in gray) based on the new X-rays using Precise Positioning Technique®. Of the 31 improved grades, 4 dogs (11.4%) improved from “fair” to “excellent” and 27 (77.1%) improved from “fair” to “good.” Three (8.6%) of the 35 dogs received the same “fair” grade and 1 was downgraded to “mildly dysplastic.” For the dogs that had previously received “fair” grades, there was an 88.5% improvement in hip grade based on the new X-ray. Both of the dogs that previously received a grade of “good” received improved grades of “excellent” based on the new X-rays.

Of interest, only 45 (22.5%) of the 200 dogs in the study received the same grades on both the first X-ray submitted and the second X-ray submitted (*i.e.*, the grades remained the same).

Old OFA Grades	New OFA Grades						
	X-rays	Moderate	Mild	Borderline	Fair	Good	Excellent
Severe	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Moderate	13	2 (15.4%)	7 (53.8%)	0 (0%)	1 (7.7%)	3 (23.1%)	0 (0%)
Mild	130	7 (5.4%)	40 (30.8%)	2 (1.5%)	34 (26.2%)	45 (34.6%)	2 (1.5%)
Borderline	20	1 (5%)	0 (0%)	0 (0%)	7 (35%)	10 (50%)	2 (10%)
Fair	35	0 (0%)	1 (2.9%)	0 (0%)	3 (8.6%)	27 (77.1%)	4 (11.4%)
Good	2	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (100%)

Table 1: OFA hip grade changes after resubmission of new X-rays
(light gray-filled boxes indicate improvements in hip grade; black-filled boxes indicate worsening of hip grades; white boxes (with black borders) on the diagonal indicate no change in hip grade)

Figure 4 shows the distribution of the actual grade-level changes (positive if improved, negative if worse, zero if no change) from the original X-ray to the Precise Positioning Technique® X-ray for all 200 dogs in the sample. If these changes were unbiased—i.e., solely the result of random categorization errors in the original radiographs, the grade-level changes would have been symmetric around zero (no change). That is, the number of new grades that improved or became worse by one grade level should be similar to each other, as should those that changed by two grade levels, three grade levels, etc.

The solid bars in Figure 4 show clearly that the preponderance of observations is in the direction of improved grades after the second X-ray with attention to positioning was submitted. Of the 163 dogs in the sample that received failing grades on the original OFA hip evaluations with moderate, mild, or borderline hip dysplasia, 113 (69.3%) received improved grades when the new films were taken and submitted. Of these 113 dogs, fully 104 (92% of the 113, 63.8% of the 163) passed with fair, good, or excellent grades based on the new films.

As mentioned above, had both the X-rays and evaluations been unbiased—that is, had the changes been due solely to random factors, the distribution of changes should have been roughly symmetric around “no change.” The data are not statistically consistent with this “no change” hypothesis. A statistical chi-square test confirms this strong visual observation; the likelihood of obtaining such a strong skew in the direction of improvement if all the changes from the original to the new radiograph and interpretation were random variations would be less than 1 chance in 100,000. These data show beyond any reasonable level of doubt the importance

of correct positioning in capturing the true anatomical structure of the dog on the radiograph for the purpose of identifying canine hip dysplasia.

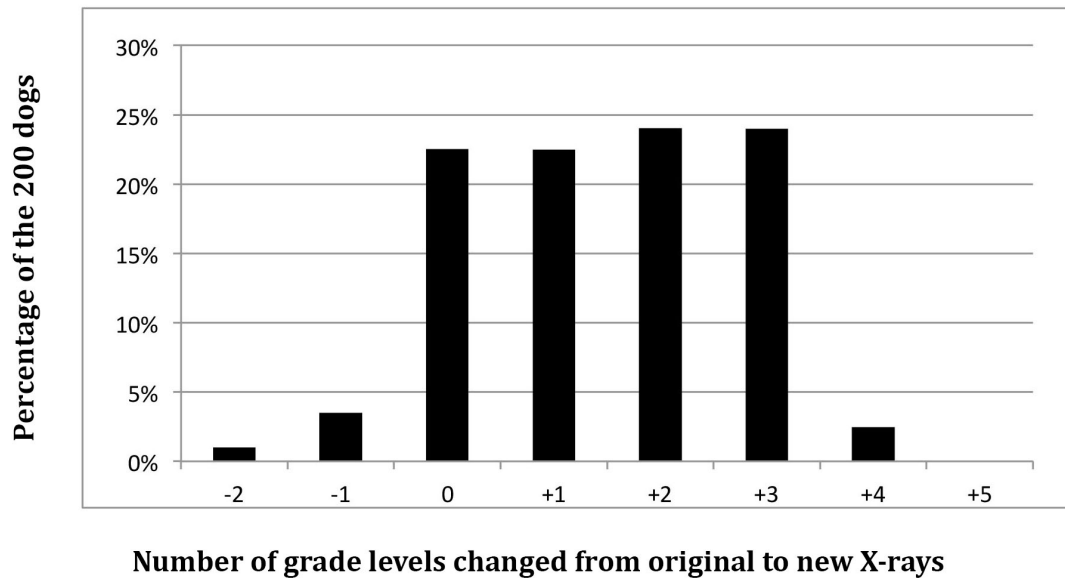


Figure 4: Graph of OFA grade changes after resubmission [(worse (-), same (0), better (+)] from original submission grade to resubmission grade

Discussion and Implications

The results are alarming because based on the initial X-rays and erroneous hip grades, otherwise fine dogs may have been eliminated from further breeding or showing. Knowing whether a dog is truly dysplastic, and to what degree, is important in determining the dog's value to breeding programs. Culling a dog from breeding because of inaccurate grades based on poorly taken X-rays and not the dog's actual anatomy is genetically, economically, and emotionally costly. Similarly, an incorrect diagnosis of dysplasia can cause the family pet owner to incur emotional costs as well as the financial costs of any medications, therapies, or surgeries that are not needed.

The Bottom Line

Any decision about the future of a dog, whether for pet, performance or show purposes, must be based on accurate diagnostic information. The results in this study demonstrate the potential for erroneously removing dogs from exhibition or performance events based on an incorrect diagnosis of hip dysplasia when, in reality, the illusion of subluxation or dysplastic changes was the result of poor positioning of the dog in the X-ray.

The data further demonstrate that many dogs receiving a passing grade of “fair” may benefit from new X-rays and resubmission as evidenced by the improvement in grade of 88% of the dogs in this study previously evaluated as fair. Obviously, if bone changes such as remodeling or arthritis are present, repeat X-rays will be of little to no value; however, for those dogs with reports indicating subluxation and/or shallow acetabulum only, breeders, owners, and handlers should seriously consider retaking new X-rays for submission with strict attention paid to positioning the dog according to published standards.

For the canine world to achieve its goal of reducing the incidence of canine hip dysplasia in purebred dogs, breeders, owners, veterinarians, radiologists, breed clubs, and evaluation registries such as OFA and PennHIP must work together. By establishing training and certification programs for veterinarians, grading appeal processes and procedures for resubmitting X-rays as well as educational opportunities for all parties, including pet owners, the goal of reducing or eliminating hip dysplasia can be furthered, improving both the general health and quality of life for all of our dogs

About the authors.

Lonnie L. Davis, D.V.M., DABVP (Canine/Feline Specialty), a graduate of The Ohio State University College of Veterinary Medicine, began his career at Shively Animal Hospital in Louisville, KY. Three years later, he opened his own practice, Troy Animal Hospital, in Troy, OH. Submitting up to 400 orthopedic X-rays annually to various certifying registries worldwide, including OFA, PennHIP and the BVA (British Veterinary Association), Dr. Davis' advice on hip and elbow X-ray evaluation is sought frequently by top breeders, owners, and handlers from around the world. He is a frequent speaker at various breed clubs, breed universities, and national specialties.

Nancy P. Melone, Ph.D., is a graduate of the University of Minnesota in Information and Decision Sciences. For her writing and editing, she was awarded the prestigious Dog Writers Association of America Maxwell Medallion, the Morris Animal Foundation Advances in Canine Veterinary Medicine Award, and the AKC Publication Excellence Award for her series on Canine Brucellosis. A breeder of health-tested, champion Bernese Mountain Dogs under the kennel name, ThornCreek Reg.d., Dr. Melone is a former trustee/treasurer of The Berner-Garde (Health) Foundation, Inc. and Bernese Auction Rescue Coalition, Inc. and editor emerita of The Alpenhorn, national breed magazine for the Bernese Mountain Dog Club of America.

We wish to express sincere appreciation to Timothy W. McGuire, Sr., Ph.D. for his assistance in data analysis and display, Ellen Folke for her meticulous proofreading, and breeders, Sandy Dunaway Summit Bernese, Cindy Valco (Somerset St. Bernards), and Priscilla Young (Powder Keg Farm's Bernese) for their suggestions on how to clarify our message to breeders and dog owners.