PROCEEDINGS OF THE DOG BREEDERS' & OWNERS' SYMPOSIUM

ON HEREDITARY CONDITIONS IN DOGS

17 APRIL 1999

Presented by the University of Pretoria

Extracts are presented below with permission and have been updated in 2012

Additional relevant South African information can be obtained from the following link:

http://www.savf.org.za/Info_Hip_Dysplasia.aspx

HIP DYSPLASIA

Prof Robert M. Kirberger
Diagnostic Imaging Section, Department of Companion Animal Clinical Studies
Faculty of Veterinary Science, University of Pretoria

Hip dysplasia is a developmental, multifactorial, genetically influenced condition that is characterized by ill-fitting or loosely-fitting hip joints and the development of secondary degenerative joint disease (arthrosis). The word dysplasia is derived from the Greek "dys" meaning abnormal and "plassein" meaning to form. As hip dysplasia is a developmental disease, it only manifests itself radiologically after the age of about 6 months. There is no doubt about the fact that the tendency to develop hip dysplasia is inherited but environmental factors like excessive protein intake and excessive strenuous exercise at a very young age play a role in the degree of dysplasia that is eventually manifested. Genetically susceptible dogs become dysplastic when the primary muscle mass that supports the joint fails to mature at the same rate as the skeletal structures. The resultant disparity between soft tissue strength and biomechanical forces during skeletal growth is manifested as a loss of congruency between the articular surfaces of the acetabulum and the femur head. This results in joint laxity and eventual hip arthrosis.

Hip dysplasia was first described in 1935 by Dr GB Schnelle but it was only in the 1950s that significant research results started appearing in the scientific literature and the seriousness of the condition became a widespread concern to breeders and veterinarians alike as it became known as an inherited disease. Since the 1950s hundreds of scientific articles have been published and many hours of research spent in trying to come to grips with this condition. Much has been learnt over the past 40 years, but as yet minimal progress has been made in preventing the occurrence of this potentially devastating disease. In the 1960s control programmes were set up in different countries by applying genetic principles and breeding programmes. Hopefully, after this symposium, breeders will have a greater understanding of the complexities of the condition and be able to make more knowledgeable decisions when breeding their dogs.

The need for a greater understanding of hip dysplasia by dog breeders, owners, and veterinarians alike is highlighted in Table 1 which shows data from the Orthopaedic Foundation for Animals (OFA) in the United States. Only breeds found in commonly in South Africa have been extracted from the data.

DIAGNOSIS

The diagnosis of hip dysplasia is usually made after the dog has shown clinical signs of the conditions or after radiographic examination to evaluate the suitability of a dog's hips for breeding purposes.

Clinical examination

Hip dysplasia is the most common orthopaedic problem affecting larger breed dogs with a prevalence of up to 43%. Lameness in the hind quarters is the most common clinical complaint. In dogs less than a year old, the clinical signs tend to be as result of the loosely fitting joint (laxity).This results in stress on the joint capsule and round ligament as well as injury to the cartilaginous acetabular rim and micro-fractures Both hind limbs, rarely only 1 limb, show episodes of lameness, usually exacerbated by exercise. Other signs seen may include difficulty in rising, walking, running and stair climbing and occasionally bunny-hopping. Once the dogs are mature, clinical signs often improve until the dogs develop severe degenerative joint disease (arthrosis). These dogs may show muscle wasting, a waddling gait, appear weak in the hind quarters, are reluctant to exercise, and prefer sitting to standing.

Hip dysplasia is not the only possible cause of the above clinical signs. A thorough clinical examination by a veterinarian as well as appropriate radiographs are required to confirm the condition and to rule out other or concomitant diseases. A complicating factor is

that the severity of radiographic changes is poorly correlated to the clinical signs. A dog with severe hip dysplasia may walk normally and a dog with mild dysplastic changes may show marked clinical signs. This is most likely due to differing pain thresholds or compensatory mechanisms in the dogs but makes it very difficult for the veterinarian to convince a breeder not to breed with a grade D or E hip dysplasia dog if the dog appears quite normal to the owner.

Table 1 (Extracted from OFA data)
BREED RISK FOR HIP DYSPLASIA : BREEDS WITH OVER 100 EVALUATIONS FROM 1974–1998

BREED	Evaluations	% Excellent	% Dysplastic
1 Bulldog	185	0.0	71.4
2 Clumber Spaniel	209	2.9	48.8
3 St. Bernard	1553	3.7	47.1
4 Newfoundland	7942	5.6	27.4
5 Staffordshire Terrier	912	1.5	26.9
6 Bullmastiff	2347	2.8	26.4
7 Bloodhound	1557	1.8	25.9
8 Gordon Setter	3922	6.5	21.8
9 Golden Retriever	72773	2.7	21.6
10 Chow Chow	3616	5.8	21.5
11 Staffordshire Bull Terrier	118	0.8	21.2
12 Rottweiler	70665	7.1	21.2
13 Mastiff	3654	5.8	20.9
14 Giant Schnauzer	2831	7.3	20.8
15 Old English Sheepdog	8416	9.7	20.7
16 German Shepherd Dog	59599	2.9	19.9
17 Bernese Mountain Dog	5421	7.3	19.5
18 American Pit Bull Terrier	129	6.2	17.9
19 Beagle	159	0.6	17.6
20 Welsh Corgi Pembroke	4160	1.9	17.3
21 Welsh Springer Spaniel	767	8.7	17.2
22 Shih Tzu	394	1.5	16.8
23 Welsh Corgi Cardigan	446	3.6	16.6
24 Bouvier Des Flandres	4734	5.0	16.5
25 English Springer Spanial	7114	7.1	16.0
26 Akita	10941	14.3	14.6
27 Chinese Shar Pei	7079	8.0	14.5
28 Airedale Terrier	2907	6.9	14.0
29 Poodle	9242	8.8	13.8
30 Labrador Retriever	93404	14.5	13.2
31 Irish Setter	7715	6.7	13.2
32 Alaskan Malmute	9673	14.5	12.4
33 Great Dane	5965	9.8	12.4
34 Border Collie	2727	9.3	12.4
35 Boxer	1812	2.6	11.9
36 Samoyed	10853	8.7	11.9
37 Cavalier King Charles Spaniel	1122	3.7	10.7
38 Great Pyrenees	3549	12.7	9.9
39 Weimaraner	6037	17.4	9.4
40 Standard Schnauzer	2368	6.8	9.3
41 English Pointer	616	12.0	8.6
42 Kerry Blue Terrier	665	10.8	8.3
43 Lhasa Apso	648	11.6	7.3
44 Keeshond	2695	7.4	7.1
45 Bearded Collie	2424	13.1	7.1
46 Cocker Spaniel	5494	9.2	7.0
47 Rhodesian Ridgeback	5170	19.4	6.8
48 Dobermann Pinscher	8353	16.1	6.4
49 Belgian Malinois	830	15.4	6.3
50 Irish Wolfhound	902	22.8	5.9
51 English Cocker Spaniel	3648	14.4	5.8
52 German Shorthaired Pointer	6809	21.5	5.6
53 Afghan Hound	4700	27.1	5.6
54 Dalmation	1979	8.1	5.2
55 Shetland Sheepdog	7014	26.8	5.1
56 Flat Coated Retriever	2347	15.0	4.8
57 Belgian Tervuren	2790	20.3	4.1
58 Greyhound	143	35.0	3.5
59 Schipperke	128	10.2	2.3
60 Siberian Husky	11635	30.3	2.2
61 Saluki	199	41.7	2.0
62 Borzoi	569	29.0	1.6

The Ortolani test is a common physical examination manipulation that may be used to diagnose instability of the hip joint, and thus hip dysplasia. It usually requires general anaesthesia. Pressure is applied via the femoral shaft towards the hip joint to subluxate the lax femoral head. On further manipulation, the head pops back into the socket resulting in a click being felt or heard. The procedure should be repeated a few times to confirm a negative Ortolani test. A false-positive Ortolani sign occurs occasionally but false-negatives are fairly common, particularly up to 18 weeks of age. Some older dogs with hip dysplasia may not demonstrate a positive Ortolani test due to extensive fibrosis (scar tissue) around the joint or the hip being totally luxated.

Radiographic examination (X-ray examination)
Radiological examination is the only definitive method of determining the presence of hip dysplasia. In severe cases, definite radiological changes confirming the condition will be present at the age of about 6 months or even earlier, but routine radiographic examination for the purpose of certification is delayed until skeletal maturity has been reached. There is a 5% possibility that hips that are normal at the age of 12—13 months can still develop a mild degree of dysplasia. It is of course also possible that many, or all, of these cases that develop hip dysplasia subsequently were not diagnosed originally due to incorrect positioning, poor quality radiographs (X-rays), or unfamiliarity with the early radiological signs. A certain degree of deterioration (about one degree) is quite possible between the ages of 1 to 2.5 years in cases showing radiological signs at the age of one year. Theoretically it should therefore also be possible to develop a grade 1 dysplasia in that time if the hips appeared to be normal at the age of one year. Although extremely rare, the reverse, namely improvement in the laxity of the hips, is also possible in cases subjected to regular exercise to strengthen the muscles responsible for holding the femoral head firmly in position. Radiographic evidence of hip dysplasia is a phenotypic expression of the condition. Normal radiographs do not necessarily mean that the dog is genotypically negative for hip dysplasia. This is part of the problem of controlling this condition and will be discussed in a later paper. In South Africa official certification is done according to FCI guidelines at 12 months or older and at 18 months in the Rottweiler and giant breeds. In the United States official certification is only done at 24 months and in the United Kingdom from 12 months onwards. Radiographs can be made in younger dogs purely for diagnostic reasons but will have to be redone at the correct age for certification purposes.
Two ventrodorsal views of the pelvis, one with the hind limbs in extension and the other in flexion, are required in South Africa. In most overseas countries the tendency is to evaluate only the extended position. The question arises which position, if any, is the more physiological and normal? Theoretically, the flexed position is the more normal one because dogs will voluntarily assume it when lying on their backs and will never extend their legs to the degree which is brought about by manual positioning! Neither do they walk around in the upright position!

General anaesthesia or heavy sedation is necessary to make good radiographs. Breeders are often reluctant to have this done due to possible anaesthetic risk, belief that anaesthesia results in increased laxity of the hip joint (and thus a poorer grading), and to decrease costs. A study by Aronson in 1991 compared readings made by the OFA on the same dogs examined with and without anaesthesia. The same reading was obtained in 83% of the dogs, 7% got a better grading and 10% got a worse grading under general anaesthesia but there was no statistical difference between the 2 groups. However, sedation or general anaesthesia results in easier and more accurate positioning and less chance of movement resulting in less radiographs having to be taken (less radiation exposure to dog and workers) and decreased risks of radiographs being returned by the scrutineer for technical faults. Some of the newer drugs can be reversed after the procedure allowing the dog to be ambulatory soon after the radiographs have been made.

Optimal radiographic technique ensuring maximal visibility of detail is required to see some of the very subtle changes that the scrutineer looks for when evaluating hip dysplasia radiographs. The X-ray film should be permanently identified with at least a tattoo or microchip number, registered name, date, and veterinary practice.

Meticulous care should be given to correct positioning. For the extended view particular attention should be paid to achieving pelvic symmetry and proper inward rotation of the limbs so that the patellas form the most dorsal points of the stifles (Figure 1). Lateral tilting of the pelvis and failure to rotate the limbs sufficiently in the extended position will cause apparent anatomical deviations which can easily be mistaken for mild hip joint laxity (which is one of the signs of mild hip dysplasia).

Transitional vertebrae are occasionally identified by the radiologist and are reported as such. This is a congenital malformation of the spine and at the lumbosacral junction is known as sacralization of the last lumbar vertebra. The condition is seen most commonly in the German Shepherd Dog with an incidence of up to 8% reported. The condition is usually not associated with clinical signs but could have a familial tendency and the dog should only be bred with one of the opposite sex that is normal. Symmetrical positioning of the pelvis in the extended position is difficult if not impossible when sacralization of L7 is present. In this condition some lateral tilting of the pelvis occurs relative to the spine. Unilateral sacralization complicates the diagnosis of hip dysplasia for two reasons:

(a) the apparent effects which lateral tilting has on both hip joints (discussed earlier). This can mask signs of mild dysplasia in the opposite hip due to artificial improvement in its status and create apparent signs of dysplasia in the elevated hip
(b) the definite tendency for mild secondary osteo-arthrosis to develop in the elevated hip joint (the one towards which tilting

occurs) due to inadequate seating of the femoral head in the acetabulum and the stresses related to such abnormal seating. The elevated acetabulum will provide less acetabular roof surface with which the femoral head can articulate and vector forces will stress the joint by tending to subluxate it. Mild secondary arthrosis is also associated with early hip dysplasia and this is why the evaluation is complicated.

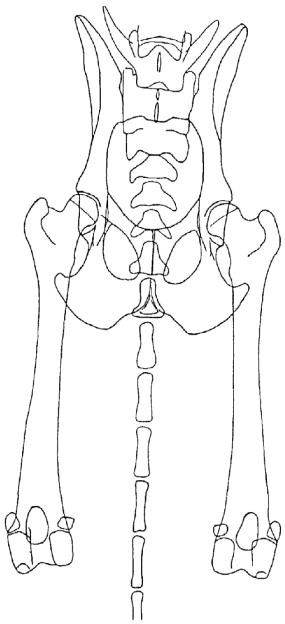

Figure 1 Schematic representation of well-positioned extended hip radiograph

Radiographing dogs that are pregnant or in oestrus is a contentious issue. A study by Hassinger showed that there was no statistically or clinically significant change in hip joint laxity in bitches studied during the various stages of the oestrus cycle. However the OFA recommends that radiographs be made one month after weaning of pups or 1 month before or after a heat cycle and where possible this is probably still the safest route to follow.

The extended, and to lesser extent, the flexed method of positioning has been used for the past 40 years or more and is the standard positioning used by the OFA in the USA, the British and Australian schemes, and most of the European countries. The lack in progress in eliminating hip dysplasia, the physiologically abnormal positioning, and the inability to predict hip dysplasia status in very young dogs, have stimulated much research in developing alternative radiological positions. Currently stress radiography is becoming popular and will be discussed later.

Evaluation and grading

Unfortunately, there is no standard international grading scheme (Table 1) and this has led to much confusion amongst breeders, particularly if wishing to import or exports dogs or semen. The grading system used in South Africa is an FCI scheme (Table 2). The Federation Cynologique Internationale, as well as the World Small Animal Veterinary Association, have attempted since 1974 to standardise grading schemes without much success.

They have however standardised terminology and set guidelines which in South Africa include:

a) Minimum age of examination is 1 year with 18 months for giant breeds and rottweilers.
b) Dogs should be positively identified (tattoo or microchip) and this information to be present on the pedigree certificate and on the radiographs.
c) Left and right sides must be marked on the radiographs as well the date of the examination.
d) A method of appeal must be available.

To complicate matters further, in individual countries, certain breed societies still have their own grading schemes which differ from the above basic standards of A—E or 0 - 4. For example, the GSD Federation scheme in SA uses A, A°, A, C, and D grades. In the United Kingdom a completely different grading scheme is used (see Table 2). The same general interpretation principles apply but they give a score of 0—6 for 8 individual radiographic characteristics and 0—5 for additional characteristic. The score for each hip can thus theoretically range from 0—53. The same scheme is used in Australia and New Zealand.

A certain degree of subjectivity is built into the radiological diagnosis of canine hip dysplasia, irrespective of which of the above grading schemes is used. The subjectivity can be minimised by using scoring panels where consensus is obtained by using more than one scrutineer, using experienced evaluators and preferably using only qualified specialist veterinary radiologists. In the USA and UK the hip dysplasia schemes have a panel of eight or more specialists who can be called upon to evaluate radiographs. In South Africa, with its relatively small population of veterinarians, there are currently several small animal radiologists who evaluate radiographs in their private capacity for the various organisations controlling dog breeding in South Africa. Control schemes are usually run by the major dog controlling bodies in tandem with the national veterinary associations. In South Africa, due to lower numbers, these organisations do not have the financial muscle that their sister organisations in the larger countries have and this, together with the limited number of specialist radiologists, makes it very difficult to run similar schemes to those in place overseas.

Table 2
INTERNATIONAL HIP GRADING SCHEMES

FC I Classification	Classification	Country								FCI Classification
		SF Finland	**NL** The Netherlands	**D** Germany	**S** Sweden	**CH** Switzerland	**ZA** South Africa	**USA** OFA	**UK*** BVA (0 - 106)	
A1	No signs of hip displasia	Ei-dysplasiaa Ahyvät@	Negatief geheel gaaf (1)	Kein Hinweis für HD	Utmärkt	Frei	0	Excellent (normal)	0	A1
A2		Ei dysplasiaa	Negatief niet geheel gaaf (2)		U.A.			Good (normal)	0 - 6	A2
B1	Transitional Case	Rajatapaus	Transitional case (Tc)	Übergangs-form (verdächtig für HD)				Fair (transitional)	6 - 12	B1
B2					I	I	I	Borderline (transitional)	12 - 18	B2
C1	Mild HD	I	Licht positief (3)	Leichte HD				Mild	18 - 24	C1
C2									24 - 30	C2
D1	Moderate HD	II	Positief (32)	Mittlere HD	II	II	II	Moderate	30 - 42	D1
D2			Positief (4)						42 - 54	D2
E1	Severe HD	III		Schwere HD	III	III	III	Severe	54 - 66	E1
E2		IV	Positief optima forma (5)		IV	IV	IV		66+	E2

Adapted from FCI, BVA and OFA data. The author does not accept responsibility for any inconsistencies which may be present in the above table.
*Autor=s placement of scores in FCI classification - guideline only. The SA grading scheme is the pre-2007 scheme after which it changed to the FCI system.

Table 2
FCI GRADING SCHEME

Description of grading applicable to dogs aged more than one year, provided positioning is correct and radiographic quality is optimal.

FCI Grade	*Description*	F C I criteria
A1	Excellent hips	No signs of hip dysplasia
A2	Good hips	
B1	Fair hips	Near normal hip joints
B2	Marginal dysplasia	
C1	Mild dysplasia	Mild hip dysplasia .
C2	Mild to moderate dysplasia	
D1	Moderate dysplasia	Moderate hip dysplasia
D2	Moderate to severe dysplasia	
E1	Severe dysplasia	Severe hip dysplasia
E2	Very severe dysplasia	

***PennHIP*® scheme**

The PennHIP scheme was developed by Dr G Smith and associates at the veterinary school of the University of Pennsylvania. They believe that the techniques described above have diagnostic deficiencies and result in false-negative diagnoses. The persistent high prevalence of hip dysplasia prompted them to research a sensitive and specific diagnostic method and in particular, a method that may have an earlier predictive value. A stress-radiographic method to quantify hip joint laxity and congruency was developed. They found that the normal extended view of the hip resulted in spiral tensioning of the joint capsule which prevented the detection of mild joint laxity resulting in an apparent normal hip joint.

A ventrodorsal view of the pelvis is made with the hips in a neutral position (i.e. equivalent to the normal standing position). A compressive device is first used to seat the femur heads in their most congruent position. This is followed by using a distraction device to apply a lateral distractive force on the hip joint. The distractive and compressive forces are maintained on

the hips long enough to make the radiographic exposures. The technique also requires general anaesthetic or heavy sedation. Compression and distraction indices (CI & DI) are then measured. Circle gauges are used to determine the centre point of the femur and acetabulum on both views. Circle gauges are used to determine the centre point of the femur moves laterally to that of the acetabulum. With joint laxity, the centre point of the femur moves laterally to that of the acetabulum and the magnitude of this distance is a direct measurement of hip joint laxity (and thus hip dysplasia). An index is then calculated for this degree of laxity; 0 being a perfect hip and 1 the worst case scenario. Exact positioning is also not critical in this technique as it is in the standard technique and examiner experience in positioning the dog is not critical. A routine extended view is still made to assess secondary arthritic changes.

Results of Smith's work indicate that the DI is up to 2.5 times more sensitive than the standard radiographic view to detect hip joint laxity. Dogs with a DI of <0.30 are believed to be truly negative for hip dysplasia. The DI is also a reliable indicator for determining susceptibility of hips to future arthrosis. Smith also showed that in the German Shepherd dog, the DI measured at 4 months and 12 months were comparable. This is a major breakthrough in that it allows hip dysplasia to be determined at a very young age which has major breeding and financial advantages. All dogs done at such a young age should however have the procedure redone at maturity to confirm the DI values.

The above work is very exciting and shows great promise in decreasing the incidence of hip dysplasia over time. The success of the scheme resulted in it quickly growing beyond the capacity and purpose of a university laboratory. In 1993, in order to make the technology available for more widespread use, the procedure was licensed to International Canine Genetics (ICG) which has subsequently been purchased by Synbiotics Corporation. The latter manage and market the PennHIP® technology while Dr Smith and his colleagues continue their research at the University of Pennsylvania. It is thus a registered trade mark and as such is strictly controlled and is run for profit. Veterinarians have to do a course (which they pay for) to become registered approved evaluation centres. All radiographs are sent to a central point for evaluation. To date more than 20 000 dogs have been evaluated.

Discussions were held by the author with Dr Smith to introduce the system into South Africa but there were insurmountable problems. Because of some of these problems, similar distraction schemes are being developed in Europe and could theoretically be developed in South Africa.

Evaluating younger dogs

Frequently, dog breeders want early knowledge of the hip status on puppies in a given litter. This allows early selection of dogs for use as show/performance/breeding animals or dogs that would be best suited for pet homes. Preliminary grading on puppies as young as 4 months of age can be done by means of routine extended hip radiographs. These may be as valuable to the owner or breeder as the final evaluation. If the dog is found to be dysplastic at an early age, the economic loss from cost of training, handling, showing, and so forth can be minimized and the emotional loss reduced. Reliability of preliminary evaluation increases as age at the time of preliminary evaluation increases, regardless of whether dogs received a preliminary evaluation of normal hip conformation or hip dysplasia. However, dogs that receive a preliminary evaluation should be reevaluated at the usual certification age.

FACTORS INFLUENCING POOR PROGRESS IN ELIMINATING HIP DYSPLASIA

1. Polygenic mode of inheritance.
2. Environmental factors may suppress phenotypic expression of condition.
3. Many breeds do not have compulsory hip dysplasia schemes.
4. Poor breeder compliance. This includes breeding with affected dogs, particularly breeding with higher grades as is still allowed by some breeds. It is advisable to breed with an A - A dog and bitch. If one is using a grade B – A or B – B dog or bitch breed with an A – A of the opposite sex.
5. Severely affected hips are not sent for evaluation by the breeder/veterinarian. Breeding may continue with these dogs and lack of phenotypic information hampers genotype assessment by central registries.
6. Lack of progeny testing schemes to find good genotypes and not having records of the hip dysplasia status of the dog's ancestors.
7. Radiographing at 12 months of age is not ideal as grading can worsen up to 24 months.
8. The standard extended hip radiograph is responsible for appreciable variability in determining the hip phenotype, and this variability has obscured our understanding of the genetic basis of hip dysplasia in dogs. False-negatives may result which is harmful to the gene pool.
9. The accuracy of a diagnostic test has a profound impact on the hereditary value. Inaccuracy of the test (in this case radiographic method) lowers the estimate of heritability. Heritability of the hip dysplasia phenotype on the routine hip-extended view has not been extensively studied. PennHIP® estimates have yielded high heritability values for the DI (hip laxity), e.g. German Shepherd Dog 0.48 and Labrador retriever 0.60.
10. According to the OFA the low screening rates for some breeds offer some insight into the problems involved with reducing the incidence of hip dysplasia. The typical dog breeder is involved in breeding dogs for about 5 years. Thus, informed, experienced breeders are continually replaced with uninformed, inexperienced breeders who may not be as aware of the problems associated with hip dysplasia or of the importance of participating in a screening program. In addition, many breeders choose which dogs they breed on the basis of the hip phenotype of individual dogs without knowledge of the phenotype of related dogs or previous offspring. It can be very difficult to get hip information on siblings and previous offspring due to the overall low number of dogs radiographed in a given litter (most dogs in a litter end up in pet homes). This is the slowest method of reducing the incidence of an undesirable trait or increasing the incidence of a desirable trait. The use of preliminary radiographs as early as 4 months of age on entire litters can be used by breeders to add valuable information on the hip status of dogs they choose to use in a breeding.

THE DOG WITH A D2-D2 GRADE FROM HIP-DYSPLASIA FREE PARENTS & GRANDPARENTS

1. Parents could still be genotype +.
2. Parents were evaluated at 1 year and the phenotype may not have developed yet.
3. Environmental factors unfavourable (overfeeding and too much exercise).
4. Poor radiographic technique, scrutineer inexperience, and interevaluator variability.
5. Administrative mix-ups.
6. Breeder dishonesty — selling pups from dysplastic parents as pups from hip-dysplasia-free parents.

DIFFERENT GRADING ON APPEAL

Breeders are often not happy with a grading and may resubmit the same radiographs again to a different scrutineer and obtain a different grading. Possible reasons for a different grading include the following:

Scrutineer inexperience and intra- and inter-evaluator variability. According to the OFA, when results of 1.5 million radiographic evaluations by 35 radiologists were analysed, it was found that all 3 radiologists agreed as to whether the dog should be classified as having a normal phenotype, borderline phenotype, or hip dysplasia 94.9% of the time. In addition, 73.5% of the time, all 3 radiologists agreed on the same hip phenotype (excellent, fair, good, borderline, mild, moderate, or severe). In 21% of the time, two radiologists agreed on the same hip grade and the third radiologist was within 1 hip grade of the other 2. In only 5.4% of the time two radiologists agreed on the same hip grade and the third radiologist was within 2 hip grades of the other 2. This percentage of agreement is high considering the subjective nature of the evaluation but frustrates breeders when differing results lead to confusion. Intra-evaluator differences in interpretation are probably similar. The PennHIP® scheme claims much higher repeatability and consistent intra- and inter- evaluator interpretation of DI measurements.

REFERENCES

1. Orthopaedic Foundation for Animals (OFA), United States. http://www.offa.org
2. University of Pennsylvania hip improvement program (PennHlP®), United States. http://www.vet.upenn.edu/pennhip
3. Adams WM *et al*. 1998. Early detection of canine hip dysplasia: Comparison of two palpation and five radiographic methods. Journal of the American Animal Hospital Association, 34:339-347.
4. Alexander JW (ed.) 1992. Canine Hip Dysplasia in: The Veterinary Clinics of North America (Small Ani,nal Practice),

22:503-743.
5. Aronson E *et al*. 1991. The effect of anesthesia on the radiographic appearance of the coxofemoral joints. Veterinary Radiology, 32:2-5.
6. Cook JL *et al*. 1996. Pathophysiology, diagnosis, and treatment of canine hip dysplasia. Compendium Continuing Education (SmallAnimals,), 18:853-866.
7. Corley EA *et al*. 1997. Reliability of early radiographic evaluation for canine hip dysplasia obtained from the standard ventrodorsal radiographic projection. Journal of the American Veterinary Medical Association, 211:1142-1146.
8. Gibbs C 1997. The BVA/KC scoring scheme for control of hip dysplasia: interpretation of criteria. Veterinary Record, 141:275-284.
9. Hassinger KA *et al*. 1997. Effect of oeslrus cycle on coxofemoral joint laxity. Veterinary Comparative Orthopaedics and Traumatology, 10:69-74.
10. O'Brien RT *et al*. 1997. Dynamic ultrasonographic measurement of passive coxofemoral joint laxity in puppies. Journal of the American Animal Hospital Association, 33:275-281.
II. Smith GK *et al*. 1990. New concepts of coxofemoral joint stability and the development of a clinical stress-radiographic method for quantitating hip joint laxity in the dog. Journal of the American Veterinary Iviedical Association, 196:59-70.
12. Smith GK *et al*. 1998. Reliability of the hip distraction index in two-month old German Shepherd Dogs. Journal of the American Veterinary Medical Association, 212:1560-1563.
13. Smith GK *et al*. 1993. 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 in dogs. American Journal of Veterinary Research, 54:1021-1042.