Hip schemes

It has been known for some time that CHD is an inherited condition and, as such, by identifying the carriers, it should be possible to decrease its prevalence and severity. As the condition is polygenic, screening for specific genes is not yet a possibility, thus, identification of carriers is by phenotype and not genotype.

Basically, all hip improvement schemes attempt to predict the likelihood of hip OA. The standard BVA/KC scheme selects as its phenotype changes to the hip joints as seen on a hip-extended radiograph with various changes to the joint being scored as to their severity. These changes fall into three categories: subluxation, joint remodelling and OA. Similar schemes include the Orthopedic Foundation for Animals (OFA) scheme of the USA, the Federation Cynologique Internationale scheme of Europe and the German SV – a stamp scheme. The BVA/KC hip scheme advocates owners to breed from dogs that are well below the breed mean score. However, it is apparent to breeders and veterinarians that the hip status of the national canine population has not seemingly improved over the many years of the scheme’s existence. The BVA and KC will argue that breed mean standards have improved, but, as there is no compulsion to submit all radiographs, many with high scores are not submitted, thereby saving the owner the submission fee, but skewing the breed mean scores – making them non-representative.

Orthine nine parameters scored on each hip by the BVA/KC – it is only the Norberg angle that can be measured objectively; the rest are subjective assessments with both intra- and inter-assessor agreement variance.

The screening test is also affected by positioning: with the hip-extended view artificially tightening the hip joints. In addition, although OA changes are scored, no indication of its significance is given to the breeder. The diagnostic test of any scheme has to evaluate hip phenotype as an estimate of the genotype, and its relationship is the concept of heritability. A high heritability approach means one that makes the phenotype accurately reflects the genotype. Heritability of a given trait is lowered if environmental factors, such as diet or exercise, can influence the trait’s expression. Diagnostic error also lowers the estimate of heritability – making the measure less useful as a hip screening tool.

Schemes in the hip-status of the offspring are also governed by selection pressure, which is defined as the deviation of the parental mean from the population mean. An example would be breeding parents with a mean hip score of, say, five when the breed average is four. This would greatly increase the selection pressure, whereas if the mean parental hip score was four, then the selection pressure would be low.

As heritability is a quantitative trait it is possible to calculate the expected change in average litter phenotype after one generation, using the mathematical formula:

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\text{Genetic change per generation} = \text{heritability multiplied by selection pressure.}
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Conversely, by knowing the hip scores of the litters, it is possible to calculate the degree of the ‘heritability of the diagnostic test’.

In two well-executed studies of subjective hip scoring using the OFA method in the German shepherd dog, breed estimates of heritability were 0.22 and 0.43, and in four other breeds it was found to be 0.26. These degrees of heritability are considered low, meaning that genetic change will be slow. Moreover, due to the fact that breeding does improve the hip status over a few generations there would be a decrease in the phenotypic and genetic variance to a point when further improvement is not possible.

This may well be contributing to the failure of the BVA/KC scheme, as a steady state has been reached by the determined breeders and further improvement is not possible.

PennHIP

An improvement in decreasing the incidence of CHD can, therefore, be achieved by using a screening test with a higher heritability and ample range in the metric to enable applying significant selection pressure. The only such test available is the PennHip Improvement Program (PennHIP). It is the only hip screening method capable of quantifying the risk for osteoarthritis as a result of hip dysplasia, and is based on the measurement of hip joint laxity.

The screening test necessitates taking three different radiographic views of the hip. A standard and hip-extended view allows the reporting of OA already present, while the compression (Figure 1) and distraction (Figure 2) views enable the calculation of the distraction index (DI). As the hip is anaesthetised, the DI is a measure of passive hip laxity with the muscular forces on the joint eliminated.

The DI is a linear scale that directly measures the degree of subluxation or laxity; a DI of 0.8 would indicate that 80 per cent of the femoral head was subluxated from the acetabulum, whereas a DI of 0.25 indicates there is only 25 per cent subluxation and, thus, the hips are described as tighter. There is a degree of passive joint laxity in the hips of all breeds and a DI of more than or equal to 0.3 is considered normal, with virtually no risk of developing subsequent OA. However, the laxity profiles of different breeds vary, as can be seen in Figure 3, which plots the probability of developing OA at 24 months of age against the DI.

Heritability of DI varies from different studies and averages out at around 0.65 (range 0.42-0.85), but it is always considerably higher than the heritability of subjective hip scoring methods. Using high selection pressure from the moment of birth, or of the closed colony, enables rapid improvement in hip status of the offspring in just a few generations. Breeders like to select other genetic factors in breeding programmes, and dogs having the highest hips may be undesirable for other traits. But, by using the DI method, it is possible that the breeding stock is from the tighter side of the breed mean hip, improvement can still be achieved, albeit more slowly, than if maximum selection pressure were applied.

Another advantage of the PennHIP method is that pups can be accurately assessed from 16 weeks of age, and subsequent submissions are allowed and, indeed, encouraged. In addition, all cases have to be submitted for analysis, and therefore, the breed mean DI scores are free of selection bias and are more accurate.

The disadvantage of the PennHIP method is that, until now, it has relied on manual measurement of the compression and distraction radiographs, and that contravenes UK radiation safety rules. However, a hands-free technique has been evaluated that is both cheap and simple, and this will allow UK veterinarians to take PennHIP radiographs and to become PennHIP certified.

The major disadvantage of the BVA/KC scheme is that it can produce false-negative results in that many dogs scored as having good hips will have an unacceptable degree of laxity and will go on to develop OA and, therefore, should not be used for breeding. However, the strength of the BVA/KC scheme is that any dog with a high hip score will have bad hips, meaning no false positives.

The PennHIP system is rapidly gaining worldwide acceptance, and with more than 80,000 dogs on its database, it is poised to be the next standard hip screening method. The first UK hands-free PennHIP course will take place in Cambridge on December 3. Details can be obtained by emailing pennhip@pennhip.org.

References


Further reading


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Schemes plus screening strategy to reduce inherited hip condition

Discusses hip dysplasia in dogs and how the popularity of a hip improvement programme could help decrease the condition’s prevalence.

Figure 1: PennHIP compression view.

Figure 2: PennHIP distraction view.

Figure 3: Graph showing the probability of developing osteoarthritis in four different breeds of dog at 24 months of age.

German shepherds (n=3729) 0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1

Golstein retrievers (n=6454) 0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1

Labrador retriever (n=6278) 0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1

Rottweiler (n=1191) 0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1

Figure 4: Probability of developing arthritis in dogs at 24 months of age

0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1

Relationship between number of visits to an animal orthopaedic surgeon and probability of developing osteoarthritis in dogs, 24 (9)