Schemes plus screening strategy to reduce inherited hip condition

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discusses hip dysplasia in dogs and how the popularity of a hip improvement programme could help decrease the condition's prevalence

CANINE hip dysplasia (CHD) is a common cause of pelvic limb lameness and exercise intolerance. The dictionary definition of dysplasia is abnormal growth or development and, as such, CHD is a developmental condition and is not congenital.

CHD is present in almost all breeds and must be seen as a result of breeding programmes selected to accentuate characteristics that are desirable for the various breed standards. Breeds, such as the racing greyhound – where the selection process is towards racing performance – have normal hips and do not develop the osteoarthritis (OA) associated with CHD.

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/Kennel Club (KC) hip 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 Fédération Cynologique Internationale scheme of Europe and the German SV – a stamp scheme.

The BVA/KC hip scheme advises 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.

Of the 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 scores for subluxation are 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 approaching one means that 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.

Improvements 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 mean is 18. This would greatly increase the selection pressure, whereas if the mean parental hip score was 14, 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: genetic change per generation equals heritability multiplied by selection pressure. Conversely, by knowing the hip scores of the litter, it is possible to calculate the heritability of the diagnostic test[1].

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[2] and 0.43[3], and in four other breeds it was found to be 0.26[4]. These degrees of heritability are considered low, meaning that genetic change will be slow. Moreover, if selective breeding does improve the hip status, over a few generations there would be a decrease in the phenotypic and genotypic 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.

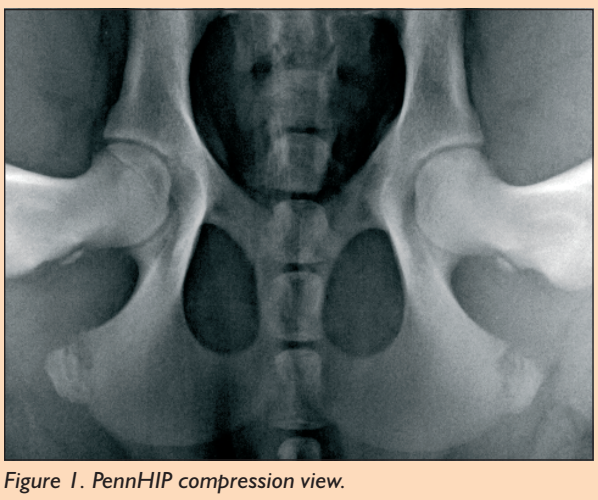

Figure 1. PennHIP compression view.

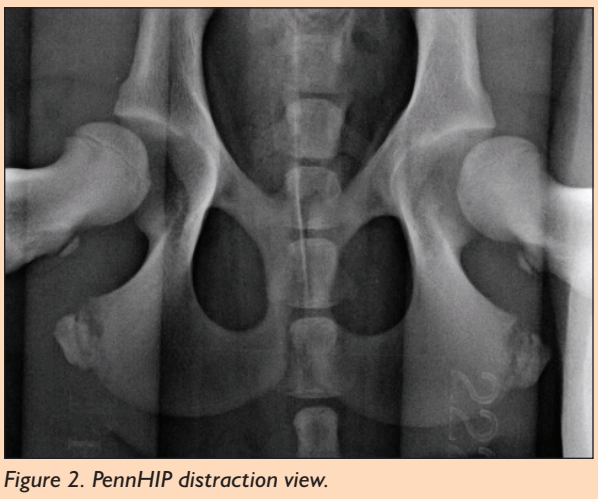

Figure 2. PennHIP distraction view.

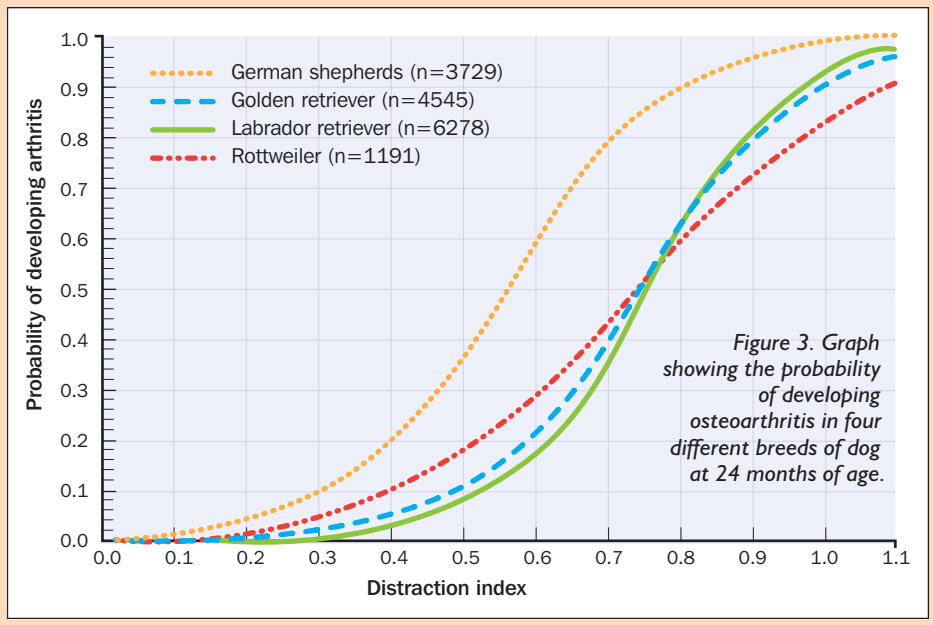

Figure 3. Graph showing the probability of developing osteoarthritis in four different breeds of dog at 24 months of age.

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 Pennsylvania Hip 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 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 dog 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 hip 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[5].

Heritability of DI varies from different studies and averages out at around 0.65 (range 0.42 to 0.92), but is always considerably higher than the heritability of subjective hip scoring methods. Using high selection pressure from the DI profile of the breed, 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 tightest hips may be undesirable for other traits. But, by using the DI method, providing 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 holding to obtain 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, 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-info@pennhip.org

References

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Further reading

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MIKE GUILLIARD graduated from the University of Cambridge Veterinary School in 1972 and has spent his entire professional career in general practice with what is now Nantwich Veterinary Group. He gained the certificate of small animal orthopaedics in 1995 and has twice gained the BSAVA Dunkin Award. His publications have been mainly on distal limb lameness and he has lectured in both Europe and the USA.