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The effects of positioning, reason for screening and the referring veterinarian on prevalence estimates of canine hip dysplasia

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ABSTRACT

Although the prevalence of canine hip dysplasia (HD) has been the subject of a number of published studies, estimates vary widely. This study evaluated several possible causes for these differences. Sixty Belgian, Dutch and German veterinarians were asked to submit all hip radiographs obtained for screening purposes (irrespective of HD status) over a 2-year period, resulting in a database of 583 dogs. Each set of radiographs was accompanied by information on the reason for screening (breeding soundness examination, clinical complaint, assistance dogs, or other reasons), and dog breed, date of birth and age.

Dog positioning exerted an effect at multiple levels. The agreement among different observers regarding correct or incorrect positioning was limited and incorrect positioning itself reduced the inter-observer agreement for radiographic hip conformation. Dysplastic dogs were more commonly positioned incorrectly than non-dysplastic dogs. The clinical complaint population had a high prevalence of dysplastic dogs (>70%) compared with the breeding population (11%) and the assistance dogs (6%). There was a significantly lower prevalence of HD among cases referred by veterinarians who frequently submitted hip-extended radiographs for evaluation ($P = 0.002$) compared to those who refer less frequently. However, this was likely to be selection bias, as radiographs that were from dogs suspected to be dysplastic were not submitted by frequent senders. The prevalence of dysplastic dogs varied widely between breeds (16.7–71.4%). Dogs diagnosed with dysplasia were significantly older than dogs considered healthy ($P = 0.001$) and dogs classified as borderline dysplastic ($P = 0.035$). Inter-observer agreement for hip conformation was moderately low, resulting in >7% variation in prevalence estimates for dysplasia.

Introduction

Canine hip dysplasia (HD), first described in 1935, is a multifactorial, polygenetic disorder (Schnelle, 1935) mainly characterized by hip joint laxity, which eventually leads to degenerative joint disease (DJD). This debilitating disorder is a common reason for euthanasia in dogs (Bonnett et al., 2005).

A broad spectrum of clinical and radiographic techniques can be used to diagnose HD (Fries and Remedios, 1995). The most frequently applied technique is the standard ventrodorsal (VD) hip-extended radiograph. Three other radiographic methods used to identify laxity are the PennHIP distraction index, the subluxation index and the dorsolateral subluxation score (Smith et al., 1990; Farese et al., 1999; Fluckiger et al., 1999).

To reduce the prevalence of this disease, three major pedigree dog organizations, the Fédération Cynologique Internationale (FCI), the Orthopedic Foundation for Animals (OFA) and the British Veterinary Association/Kennel Club (BVA/KC), use VD hip-extended radiographs to grade the hips of potential breeding dogs (Verhoeven et al., 2012). In Belgium, canine pelvic radiographs are evaluated by the National Committee for Inherited Skeletal Disorders (NCISD). For certain breeds, screening for HD is obligatory and affected dogs are restricted or prohibited from breeding. To assess whether screening has beneficial effects, prevalence must be estimated. However,

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Table 1
Overall inter-observer agreement.

	Agreement	κ ± SE	95% CI	Strength of agreement
Conformation – all[a,b]	0.789	0.827 ± 0.014	0.800–0.854	Almost perfect
Conformation – agreed[a,c]	0.799	0.833 ± 0.015	0.804–0.863	Almost perfect
Positioning	0.732	0.318 ± 0.043	0.233–0.403	Fair

SE, standard error; CI, confidence interval.
[a] κ with quadratic weighting.
[b] All dogs ($n = 583$).
[c] Dogs where both assessors agreed on correct or incorrect positioning ($n = 427$).

several studies reported variable prevalences across and within breeds (Leppanen and Saloniemi, 1999; Paster et al., 2005; Coopman et al., 2008; Genevois et al., 2008).

Radiographic positioning has been shown to affect the appearance of anatomical structures (Thompson et al., 2007), so it follows that incorrect positioning could perhaps reduce inter-observer agreement. Based on clinical experience, we hypothesized that dogs with HD would be positioned incorrectly more frequently than those without HD. We also hypothesized that the prevalence of HD would change depending on the reason for screening (breeding soundness examination, clinical complaint, assistance dogs, or other reasons), with the highest prevalence found in those dogs presented with clinical signs of hip disease. Additionally, selection bias has been reported to affect the prevalence of HD when radiographs submitted for official evaluation are investigated (Paster et al., 2005), and we aimed to determine whether the number of radiographs sent by each veterinarian would be an independent risk factor for the diagnosis of HD. Dysplastic dogs are older than their healthy counterparts (Smith et al., 2006) and there are breed differences in prevalence (Coopman et al., 2008). Positioning can also affect diagnostic outcome and VD radiographs are typically associated with a low inter-observer agreement on the presence or absence of HD (Verhoeven et al., 2007, 2009, 2010).

The aim of this study was to evaluate the effect of the following parameters, which could potentially influence estimates of HD prevalence: (1) radiographic positioning; (2) the reason for screening, and (3) the referring veterinarian.

Materials and methods

Dogs

For the purposes of this study, 60 veterinarians were asked to send in every hip radiograph obtained for screening purposes (irrespective of HD status) during a 2-year period. This resulted in a sample set of 583 Belgian, Dutch and German dogs.

Approval from the local ethical (Faculty of Veterinary Medicine, Ghent University, Belgium) and deontological (Federal Public Service Health, Food Chain Safety and Environment, Brussels, Belgium) committees was granted (EC2010_171, 28 January 2011 and EC2011_193, 20 January 2012).

Radiographic evaluation

Standard VD radiographs ($n = 583$) were independently evaluated by two veterinarians experienced in the field of HD and film reading. The following questions were answered: (1) is the dog correctly positioned to assess hip conformation (yes or no)?; (2) based on the presence of laxity, incongruency, bony remodelling and/or other degenerative changes on the more severely affected hip, would you consider the dog healthy, borderline or dysplastic? (Smith, 1997; Dassler, 2003); (3) if HD has been diagnosed, was the diagnosis based on the presence of degenerative joint disease (DJD), laxity (based on sub/luxation) or a combination of both, assessed separately for both hips (Smith, 1997; Dassler, 2003)? Positioning was assessed according to the OFA, BVA/KC and FCI guidelines,[1–3] which required that the pelvis was not tilted, the femurs were parallel and the patellae were centred on each femur. Radiographic examples of each subjective assessment are provided in Fig. 1.

Reason for screening

For each radiograph, veterinarians were asked to provide details of the reason for screening (breeding purpose, clinical complaint, assistance dogs, other reasons), breed, date of birth and age.

Referring veterinarians

To assess the effect of the referring veterinarian performing the radiographic procedure, the NCISD database was used. This contained radiographic results from breeding dogs evaluated between January and September 2012 ($n = 876$). Based on the frequency with which radiographs were submitted, two groups were created. Frequent senders submitted >20 radiographs during this period, while less frequent senders submitted ≤20 radiographs.

Statistical analysis

Agreement between observers regarding positioning (correct/incorrect) and hip conformation (healthy/borderline/dysplastic) was evaluated for each radiograph ($n = 583$) using Cohen's kappa (κ),[4] applying quadratic weighting for hip conformation. Cut-offs were used as initially reported (Landis and Koch, 1977). Group comparisons were made using chi-square tests (χ^2).

To investigate the effects of variables rather than observers, only those radiographs where both assessors were in agreement were used. Further details, including sample sizes, are provided in Fig. 2. The effect of positioning on inter-observer agreement for conformation was assessed using Cohen's κ with quadratic weighting ($n = 427$). The effects of conformation were analyzed ($n = 341$), and the reasons for the diagnosis of HD, stratified by positioning, were assessed ($n = 323$ for DJD, $n = 321$ for laxity, $n = 318$ for both; χ^2). In correctly positioned dogs, the effect of the reason for screening was assessed ($n = 215$).

In the NCISD population ($n = 876$), the effect of the frequent and less frequent senders was assessed (χ^2). To assess the possible effects of positioning, the difference between the right and left Norberg angles was calculated and a comparison between the groups of frequent and infrequent senders was made (independent Student's t test).

Additionally, in correctly positioned dogs from the original population ($n = 583$), the effect of breed was assessed in the five breeds with the highest sample size ($n = 161$). Age distribution was compared using Kruskal–Wallis tests in correctly positioned dogs ($n = 268$), in the reason for screening subgroup ($n = 211$) and in the breed subgroup ($n = 145$). Post-hoc comparisons were performed using Mann–Whitney U tests. For normally distributed data, mean ± standard deviation was calculated and for nonparametric data, median and range were calculated. Statistical significance was set at $P < 0.05$ using a commercially available software package (SPSS version 21, IBM).

Results

The distributions of hip conformations, as independently assessed by each observer, were significantly different ($P < 0.001$; Fig. 3). The general agreement between observers was approximately 80% for conformation and approximately 70% for positioning (Table 1). The inter-observer agreement on conformation was higher in correctly positioned dogs than in incorrectly positioned dogs (Table 2).

A significant difference in hip conformation was demonstrated when correctly and incorrectly positioned dogs were compared

[1] See: http://www.offa.org/hd_procedures.html (accessed 10 May 2014).
[2] See: http://www.bva.co.uk/public/documents/chs_hip_scheme_procedure_notes.pdf (accessed 10 May 2014).
[3] See: http://www.dkk.dk/xdoc/120/46-2009-annex1.pdf (accessed 10 May 2014).
[4] See: http://vassarstats.net/kappa.html (accessed 10 May 2014).