Risk of simultaneous phenotypic expression of hip and elbow dysplasia in dogs

A study of 1,411 radiographic examinations sent for official scoring

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Summary
In order to look for phenotypic correlation between hip (HD) and elbow (ED) dysplasia, we used radiographic scoring obtained from 1,411 dogs of different breeds, which were evaluated for authoritative grading of both conditions. In this population, we found that the risk ratio for an animal to be simultaneously affected by HD and ED is 1.67. For a dog with ED, the risk ratio to be affected by HD increases as the ED grade increases. Similarly, for a dog affected by HD, the risk ratio to be affected by ED increases as the HD grade increases. In a dog affected by HD or ED, the clinician should look for the second condition in the same animal. Due to the low, yet positive correlation, selection against one trait will not affect the other trait sufficiently. Therefore selection has to be conducted at reduction of HD as well as reduction of ED.

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Introduction

Hip and elbow dysplasia (HD and ED) are amongst the most common orthopaedic diseases associated with osteoarthritis in medium and large breed dogs. Both are commonly considered to be polygenetically inherited developmental abnormalities (1–4). However the role of a major gene has recently been demonstrated in the development of HD in some breeds of dogs (1–5). The influence of such a gene has also been proposed for ED (2–5). Furthermore, genetic independence has been suspected between different primary lesions (1–4). While HD and ED can be present simultaneously, reports on their clinical correlation are scarce.

This study was based on 1,411 official HD and ED radiographic screenings. The purpose of this study is to report the phenotypic correlation between HD and ED, and the risk ratio linked with the two conditions.

Material and methods

Animals

Radiographs submitted for authoritative grading of HD and ED from 1999 to 2007 were retrospectively evaluated. A total of 1,411 dogs simultaneously screened for HD and ED were included in the study. In Europe, based on the recommendation of the Fédération Cynologique Internationale (FCI)[a], the minimum age for official screening is 12 months. Consequently dogs under 12 months were excluded. Poorly positioned radiographs were also excluded. Radiographic screening was performed by one official panellist (JPG) who is a professor at the Small Animal Department of the Veterinary School of Lyon. The breed and age of each dog at the time of radiographic examination were noted.

[a] World Canine Association

Radiographic screening

Hip dysplasia radiographic screening was based on a conventional ventrodorsal hip extended view. The animals were graded according to the FCI 5-class grading scale protocol (A = no sign of HD; B = near normal; C = mild HD; D = moderate HD; E = severe HD).

Elbow dysplasia radiographic screening was based on three radiographic projections: true mediolateral with the joint flexed approximately 45° (ML flexed), true mediolateral extended view (ML extended) and craniolateral-caudomedial 15° oblique (Cr15L-CdMO). The combination of the ML flexed, ML extended and Cr15L-CdMO has been shown to be the best radiographic views to diagnose primary ED lesions (un-united anconeal process, fragmented medial coronoid process, osteochondrosis of the medial aspect of the humeral condyle, joint incongruity) and secondary elbow osteoarthritis signs (6, 7). Elbow dysplasia gradation was based on the official ED grading system used in France. This system is a 5-class modified International Elbow Working Group (IEWG) grading scale (ED 0 = no sign of ED; SL = near normal; ED 1 = mild ED; ED 2 =

Table 1 List of breeds and number of dogs in each breed enrolled in the study.

Breed	Number
Alaskan Malamute	5
Australian Sheepdog	165
Bernese Mountain dog	726
Bouvier d'Appenzell	4
Bouvier d'Entlebuch	2
Cane Corso	1
Charplanina	2
Chow-Chow	1
English Cocker Spaniel	1
Épagneul Bleu de Picarde	1
Grand Bouvier Suisse	9
Kelpie	1
Matin de Naples	1
Rottweiler	341
Rhodesian Ridgeback	12
White Swiss Sheep dog	139
TOTAL	**1,411**

Table 2 Results of hip dysplasia and elbow dysplasia scores (Hip B and Elbow SL classes were excluded from the study).

Grading scales for elbow[a] and hip[b] dysplasia					
	Hip A: No sign of hip dysplasia	**Hip C: Mild hip dysplasia**	**Hip D: Moderate hip dysplasia**	**Hip E: Severe hip dysplasia**	**Total**
ED0: No sign of elbow dysplasia	1077	51	24	0	**1152**
ED1: Mild elbow dysplasia	155	6	7	0	**168**
ED2: Moderate elbow dysplasia	24	3	0	0	**27**
ED3: Severe elbow dysplasia	49	6	9	0	**64**
Total	**1305**	**66**	**40**	**0**	**1411**

Key: [a] Based on the 5-class modified International Elbow Working Group scale; [b] Based on the Fédération Cynologique Internationale (World Canine Association) scale.

Table 3
Risk ratio for a dog with elbow dysplasia to be affected by hip dysplasia.

Grade of hip dysplasia	Risk ratio for elbow dysplasia	95% CI	p value
C	1.30	0.82 - 2.06	0.28
D	2.29	1.53 - 3.40	0.001

Table 4
Risk ratio for a dog with hip dysplasia to be affected by elbow dysplasia.

Grade of elbow dysplasia	Risk ratio for hip dysplasia	95% CI	p value
1	1.19	0.67 - 2 09	0.54
2	1.71	0.57 - 5.07	0.36
3	3.60	2.20 - 5.90	0.00003

moderate ED; ED 3 = severe ED) where every dog showing a primary lesion on the radiograph is classified ED 3 (except for joint incongruity, which classes the dog as ED 1 if no sign of osteoarthritis is visible). Dogs scored as 'near normal' for HD (class B) or ED (class SL) were excluded from the study.

Data analysis

Statistical analysis was performed with a computer software package[b]. To study ED and HD correlation, the chi-square and Spearman's rank correlation tests were used. The risk ratio, together with the corresponding 95% confidence intervals, were calculated. Risk ratio was calculated for each class of dysplasia and for each breed. Risk ratio is a ratio of the probability of the event occurring in the exposed group versus a non-exposed group. Though it cannot always be computed, it is generally considered as more easily interpretable and consistent with the way people think than odds ratio. Both the risk ratio and the odds ratio compare the relative likelihood of an event occurring between two distinct groups. Odds ratio gives the ratio of the odds suffering some fate. Sometimes, the odds ratio approximates the risk ratio, but the odds ratio will overestimate the risk ratio when it is more than 1 or underestimate the risk ratio when it is less than 1 (8).

Results

There were 1,411 dogs included in this study. Four breeds composed the majority of all breeds included: Bernese Mountain dog (n = 726), Rottweiler (n = 341), Australian sheep dog (n = 165), and White Swiss Sheep dog (n = 139). In addition, 41 dogs from 13 other breeds were also included in the study (▶Table 1). There were 894 females and 517 males. The median age was 16 months. Results of the HD and ED scores (except for HD class B and ED class SL, which were excluded from the study) are described in ▶Table 2. HD and ED prevalence were 18.4% and 7.5% respectively.

Hip dysplasia and ED scores were significantly correlated (chi-square p-value <0.001). Spearman's rank correlation test value was 0.1 (p-value <0.001).

The risk ratio for simultaneous HD and ED was 1.67 (1.21–2.30) (p-value <0.001).

[b] R.2.4.1 GNU General Public License: http://www.r-project.org/

For a dog affected by ED, the risk ratio for HD increased with the grade of ED (▶Table 3). Similarly, for a dog affected by HD, the risk ratio for ED increased with the grade of HD (▶Table 4).

For Bernese Mountain dogs, the chi-squared test showed a significant correlation (p-value <0.001) between HD and ED. Spearman's rank correlation test value was 0.16 (p-value <0.001). The risk ratio for Bernese Mountain dogs found to be simultaneously affected by HD and ED was 2.24 (1.57–3.18). No other significant correlations were found in the other breeds studied.

Discussion

The HD prevalence in the present study was relatively low in comparison to a previous multibreed study: in a 14 year retrospective study conducted on 31 breeds of dogs in France, HD prevalence was 22% for Bernese Mountain dogs, 23.4% for Rottweilers, 12.3% for Australian Sheepdogs and 27.5% for White Swiss Sheepdogs (9). In France, HD and ED radiographic screening are not compulsory for breeding. Hip dysplasia screening is a routine examination while ED screening is being encouraged by several breed clubs. It is most likely that elbow radiographs are submitted for evaluation only if the breeder expects a good result for the hip radiographs. Hence, in the studied population, HD pre-screening is probably higher than commonly reported. Up to now, information related to ED prevalence in France is not available, except for the German shepherd dog (10). However it is obvious that our ED prevalence was much lower than could be expected from looking at published ED prevalences in other countries, at least in Bernese Mountain dogs and Rottweilers (11–14).

In our multibreed (see previous) study, we found a significant correlation between HD and ED. To the author's knowledge, phenotypic correlation between HD and ED has only been reported in three other studies. A Pearson correlation coefficient of 0.16 between phenotypic traits of HD and ED was found in Labrador Retriever dogs in Switzerland (15). An exploratory screening program for ED in some breeds of dogs in Italy showed that HD was significantly associated with ED (16). Dogs affected by HD had a 41% higher risk of being affected by ED (16). In Finland, a phenotypic correlation between HD and ED was 0.24 for Rottweiler dogs (5).

Similarly a breed dependent genetic correlation has been described between HD and ED, which varied from 0.31 for Labrador Retrievers to 0.19 in the Rottweiler dogs (4, 5). In Bernese Mountain dogs, a genetic correlation of 0.26 was found (4). The genetic correlation seems quite low, which suggests HD and ED are only partially influenced by the same or closely linked genes (4).

As the genetic correlation between HD and ED is breed dependent, we could assume this is also true for phenotypic correlation. In our study, a significant correlation between HD and ED was only observed in Bernese Mountain Dogs. The HD and ED correlation was slightly higher in this breed than for the remainder of our study population (0.16 versus 0.1). No significant correlation was found between HD and ED in the other breeds, which might be due to the small number of the recruited cases of these breeds. Further studies based on more cases for each breed are required to estimate breed specificity.

In daily clinical practice, when HD or ED is diagnosed, the clinician should screen the dog for the other condition. This is particularly required in case of severe ED or HD as the risk ratio for an animal with severe HD to be affected with ED is 2.29 (Table 3). Similarly, the risk ratio for an animal with grade 3 ED to present with HD is 3.6 (Table 4). Similar clinical correlations have also been described for other orthopaedic diseases (17).

In breeding practice, the existing positive correlation between HD and ED supports the possibility for simultaneous selection against these diseases. However this correlation is quite low as shown in our study and others (4, 5). Consequently, a selection based on just one of the two diseases will unfortunately not affect the other sufficiently. Effective screening plans should be targeted at HD and ED simultaneously.

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