Radiographic evaluation of elbow incongruity in Skye terriers

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OBJECTIVES: Aims of this study were to radiographically evaluate elbow congruity and to explore associations between elbow incongruity and lameness in Skye terriers.

METHODS: Mediolateral, 90°-flexed, elbow joint radiographs were obtained for 45 Skye terriers. Elbow joint incongruity was graded mild, moderate or severe by measuring the width of the humeroulnar joint space. A questionnaire provided information on lameness history for each dog.

RESULTS: In total, 49% (22/45) of the dogs had moderate or severe elbow joint incongruity which associated with lameness. Owner-reported lameness was common: 15/45 (33%) dogs had been lame when less than one year old, and 6 (14%) had been lame at an older age. All dogs presenting with lameness when older than one year had also been lame in adolescence.

CLINICAL SIGNIFICANCE: Lameness and moderate-to-severe elbow joint incongruity were common in Skye terriers and the two were associated. A novel protocol for radiographic screening of elbow joint incongruity of chondrodystrophic breeds is suggested.

INTRODUCTION

The Skye terrier is an uncommon chondrodystrophic dog breed with genetically determined, short, bowed long bones of the limbs (Martinez et al. 2007, Parker et al. 2009). Chondrodystrophy predisposes to growth disturbances of the limbs and premature closure of the growth plates can cause excessive limb deformity causing lameness in the thoracic (Lau 1977) and pelvic limbs (Radasch et al. 2008). In addition, the distal growth plate of the ulna is particularly susceptible to trauma which can cause shortening of the ulna, elbow incongruity and subluxation (Ramadan and Vaughan 1978). In Skye terriers, so-called puppy limp or Skye limp is common and often considered to be a minor non-painful problem of the adolescent dogs usually resolving with time (The Skye Terrier Club 2015). Veterinary literature on this subject is scarce (Lau 1977, Ramadan and Vaughan 1978).

The assumed hereditary basis of premature closure of the distal ulnar growth plate (Lau 1977) and elbow incongruity in chondrodystrophic breeds indicate that it might be possible to reduce the prevalence of this condition in the breed by radiographic screening. However, grading in existing elbow dysplasia screening schemes is largely based on signs of osteoarthritis (Flückiger 2011) and they do not take into consideration the specific morphological characteristics and elbow joint incongruity of chondrodystrophic breeds. The aims of this study were to radiographically evaluate elbow congruity in Skye terriers, to explore association between elbow incongruity and lameness and to propose a specific screening protocol for elbow incongruity in chondrodystrophic breeds.

The Finnish National Animal Experiment Board approved the study.

METHODS

Owners of Skye terriers were requested by the national breed club to bring their dogs for radiographic evaluation of the elbow joints to the Veterinary Teaching Hospital of the University of Helsinki. The inclusion criterion was age over six months and the exclusion criteria were conditions prohibiting sedation. The owners were given a questionnaire (Appendix S1, Supporting Information) to assess thoracic limb lameness both before and after reaching one
year of age. The questionnaire also asked about previous veterinary treatment for thoracic limb lameness; that persisting for at least one period of one week before one year of age was considered characteristic of “Skye limp”.

After physical examination, each dog was sedated and two digital radiographs of each front limb were obtained: (1) mediolateral (ML) projection of the antebrachium including elbow joint and carpus with a 90° opening angle of the elbow joint and (2) craniocaudal (CrCd) projection of the same area. Both projections were centred on the mid-diaphysis of the antebrachium. Images were magnified to make measurements as precise as possible and assessed in a random order.

The width of the humeroulnar joint space was measured from the ML projection at its widest point with a software tool ruler (Fig 1). The radiographs were graded by the first author for incongruity (INC) of the elbow joint based on the width of the humeroulnar joint (Table 1). The elbow joint was graded as normal (INC 0), when the joint space was even and the width of the humeroulnar joint space was less than 1 mm. INC was graded as mild (INC 1) when the width of the humeroulnar joint space was 1 to 2 mm, moderate (INC 2) when the width of the joint space was 2 to 3 mm and severe (INC 3) when the width of the joint space was more than 3 mm. Finally, the grading score of each individual dog was pooled and the dogs were graded as INC 0 to 3 based on the higher scoring elbow in each individual animal.

All statistical analyses were conducted using SAS® System for Windows, version 9.3 (SAS Institute Inc., Cary, NC, USA). The relationship between INC grade and lameness was assessed by cumulative logit-models, using the highest INC grade for each dog. The number of observations in some classes of the INC grade was small, and there was only one dog with both elbow joints graded as INC 0. Therefore two different classifications of the INC grade were used in the modelling: three classes (INC 3, INC 2 and INC 0/1) and two classes (INC 2/3, INC 0/1). The models included lameness as the response variable and INC as the sole fixed effect.

The relationships among gender, weight and INC grade of each dog were assessed by cumulative logit-model. These background variables were modelled separately. The same two different category-grading combinations were used for classifying INC as were used in the other model. The models included the INC grade as the response variable and the relevant background variable as the sole fixed factor.

The results were quantified as odds ratios and their 95% confidence intervals (CI) in the logistic regression and cumulative logit-models models. P values less than 0.05 were considered statistically significant.

**RESULTS**

A total of 46 Skye terriers (22 males and 24 females) were enrolled into the study. Their mean age was 3.5 (range: 0.8 to 11) years and their mean weight 14.6 (range: 10.8 to 21.2) kg. One male dog had had corrective osteotomy of the ulna, and was therefore excluded from the study.

The mean width of the humeroulnar joint space at the widest point was 1.6 (range: 0.8 to 3.9) mm. Distribution of the 90 elbow joints into the different INC grades is shown in Fig 2. The most common grade was INC 1 (n=53; 59%) followed by INC 2 (n=23; 25%).

When each dog was assessed, a difference in the grade between its two elbow joints was a common finding. In 26 (58%) dogs no difference existed between left and right elbow, in 16 (35%) dogs the difference was one grade and in 3 (7%) dogs it was two grades. When the higher grade in an individual dog was assessed, only one dog (2%) was graded as INC 0, 22 (49%) as INC 1, 14 (31%) as INC 2 and 8 (18%) as INC 3. Heavier dogs had higher INC grades: analysis by the cumulative logit model revealed that weight was associated with INC grade (P=0.04), but this relationship was not found in the model for the dichotomised (INC 2/3, INC 0/1) INC grade. The INC grade was not associated with gender.

Lameness reported by the owner was common: 15/45 (33%) dogs had been lame when less than one year old, and 6/45 (14%)
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had presented for lameness again after reaching one year of age. All dogs presenting with lameness when older than one year had also been lame in adolescence. The mean duration of the lameness was 6 (range: 2 to 21) weeks. Only five owners had consulted a veterinarian because of the lameness, and all five dogs had been treated with non-steroidal anti-inflammatory drugs and rest. The remaining 10 dogs had been rested or no action had been taken. The association between lameness and the INC grade was clear (P<0.05): 12/15 of the lame dogs had more severe incongruency (INC 2 and 3), whereas only 3/15 lame dogs had non- or only mildly (INC 1) incongruent elbows (Fig 3). All dogs that had also been lame as an adult belonged to grades INC 2 or 3, but there was no significant difference between INC grades 2 or 3 and lameness. The proportion of lameness in dogs with INC grade 2 or 3 was 8.6-fold (95% CI: 1.9 to 39.4) that with INC grade 0 or 1.

DISCUSSION

We studied radiographic INC of the elbow joints in Skye terriers, a breed that is susceptible to premature closure of the distal growth plate of the ulna (Lau 1977). The condition is probably under-diagnosed because, among the breeders of many chondrodystrophic breeds, limping puppies are regarded as normal (The Skye Terrier Club 2015).

We created a new grading system that was based on measuring the width of the humeroulnar joint space at its widest point. Several different methods to measure objectively the INC of the elbow joint and bowing of the radius on the ML and CrCd projections were tested. The width in millimetres of the humeroulnar joint space was chosen, because it was found to be most reliably visible in the radiographs. The ML 90° flexed projection was chosen because it has been shown to be reliable in the detection of INC (Blond et al. 2005). We also took CrCd radiographs of the thoracic limbs, but this projection was subsequently abandoned because it was difficult to position the short and sometimes very curved limb in the right position, and so no reliable measurements of the INC could be made from this projection. It is possible that some cases of severe lateral subluxation of the proximal radial head could have evaded detection when the assessment was based only on the ML projection. However, the radiographic protocol should be easy to perform and the grading must be as objective as possible and, due to the difficulties encountered with the CrCd projection, it is by definition less suitable as a part of a standardised protocol. Correct positioning and centring of the limb in the ML radiograph is essential. Oblique radiographs can have an effect on the apparent width of the joint space. In the flexed (e.g. 45°) elbow joint, the width of the humeroulnar joint space can alter because of rotation of the joint (Murphy et al. 1998). Also, the distortion artefact can affect the apparent shape of the joint if the x-ray beam is not centred on the area of interest (Murphy et al. 1998). This can be considered as a limitation of our study. However, the limbs of chondrodystrophic dogs are so short that this will probably not affect evaluation of the elbow joint.

According to our grading system, moderate or severe INC of the elbow joints was common in the studied population: 35% of all joints were graded as INC 2 or 3. Using the most affected joint to give the overall grade for the individual, 49% of the dogs in the study were graded as having moderate or severe INC.

Based on the owner questionnaire, lameness in Skye terriers was common, since 33% of the dogs had been lame during adolescence and 14% had also been lame in adulthood. The lameness was clearly associated with the INC grade suggesting that it was caused by elbow INC. Therefore, it can be hypothesised that the incidence of puppy limp and lameness as an adult could be reduced if the prevalence of moderate and severe INC in the breed were to be diminished. One limitation of our study is related to the questionnaire. First, it is possible that the owners had assessed lameness of their dogs incorrectly. Second, it is not known if the lameness that was reported was caused by problems other than premature closure of the growth plate of the distal ulna.

The national breed club recruited the dogs therefore it is possible that the results do not represent the entire population of Finnish Skye terriers or the populations in other countries. It is possible that owners with lame dogs participated to a larger degree. On the other hand, among the participants were many breeders of show and breeding dogs. It is estimated, that in...
Finland the population of the breed is approximately 250 dogs, thus we examined one-fifth of the national population. Additionally, as the genetic pool of this rare breed is small worldwide, it is probable that the prevalence in our study is similar to that in Finland more generally and, probably, in other countries too.

Radiographic screening of the elbow joints could be used as a tool to decrease the prevalence of elbow INC because premature closure of the distal growth plate of the ulna and the consequent INC of the elbow joint appears to be a hereditary problem in the breed (Lau 1977). Radiography is widely used in dogs for screening musculoskeletal disorders, such as hip and elbow dysplasia. However, current elbow dysplasia screening schemes are designed for non-chondrodystrophic breeds and INC is not even taken into account in grading in all countries. Therefore, a specific radiographic protocol that is aimed at chondrodystrophic breeds, such as presented here, could be beneficial. Our grading was based solely on the width of the humeroulnar joint space and osteophytes were not taken into account as is done in IEWG-International Elbow Working Group based schemes. Osteophytes were seen in 10 joints. All these joints were graded as INC 2 or 3, suggesting that grading based on elbow INC is sufficient in Skye terriers.

We conclude that elbow joint INC was common in this sample population of Skye terriers and it was associated with lameness reported by the owners. We suggest a novel radiographic protocol for screening of elbow joint INC in Skye terriers and, possibly, in other chondrodystrophic breeds, using a mediolateral radiograph and measuring the humeroulnar joint space.

Conflict of interest
None of the authors of this article has a financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

References

Supporting information
The following supporting information is available for this article: Appendix S1. Questionnaire for the owners of Skye Terriers participating in the radiographic study of the front limbs.