The Correlation of Canine Elbow Dysplasia and Serving Time in Guide Dog Labrador Retrievers in New Zealand

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Abstract

Canine elbow dysplasia (CED) is a degenerative disorder of the cubital joint leading to pain and lameness. In order to minimize the amount of guide dog Labrador Retrievers suffering from CED, the Blind Foundation Guide dogs in New Zealand uses the New Zealand Veterinary Association (NZVA) Elbow Dysplasia scheme to select dogs for training. In this retrospective study the serving time of different elbow grades were compared to see if a higher NZVA Elbow grade correlates to a shorter service time. When comparing the Kaplan-Meier Curved for the highest NZVA Elbow grade per dog, no significant different could be found. However, dogs with a clinical diagnosis of CED were found to have a significantly shorter mean service time of 3,3 years. In conclusion, this study shows no significant difference in serving time for guide dogs based on the NZVA grade at one year of age.

1. Introduction

Canine Elbow Dysplasia (CED) is a multifactorial degenerative disease of the cubital joint in dogs. The International Elbow Working Group (IEWG) determined in 1993 that CED includes the following primary lesions: Ununited anconeal process (UAP), fragmented medial coronoid process (FMCP), osteochondrosis and/or osteochondrosis dissecans (OC/OCD) of the medial humeral condyle and incongruity (INC) of the cubital joint (Michelsen, 2013). FMCP is the most common cause of CED but finding multiple causes within the same elbow is possible (Vermote *et al.*, 2010). These primary lesions lead to osteoarthritis, which is a progressive disease with degenerative processes on the cartilage (Lavrijsen *et al.*, 2012). The viscoelastic properties of the joint are decreased due to an imbalance of cartilage production and degradation and lead to pain and lameness (Frye *et al.*, 2016; Pettitt *et al.*, 2015).

CED is typically seen more often in larger breeds. A study done in UK Labrador Retrievers resulted in a prevalence of CED of 17% (Morgan *et al*., 1999, Morgan et al. 2000). The Orthopedic Foundation for Animals (OFA) reports a prevalence of 0 to 64% depending on breed, with the Labrador Retriever having 10.5% of the graded elbows reported as dysplastic. In most cases, dogs show symptoms of recurring front leg lameness at an age of six to twelve months. However, there are cases of dogs older than six years showing symptoms without an earlier history of lameness (Vermote *et al.*, 2010; Michelsen, 2013). The severity of osteoarthritis tends to increase over time, with older dogs having a higher osteoarthritis score (Lavrijsen *et al.*, 2012). As osteoarthritis causes pain and lameness, the severity of the disease might be linked to the frequency of dogs showing symptoms. This increasing severity over time could lead to an ever-decreasing function of a guide dog.

As in humans, canine behaviour can be severely influenced by chronic pain. In a study following dogs suffering from chronic pain, the owners and veterinarian noted behavioural changes. Preliminary data suggests a change in demeanour with more dependence and unwanted behaviour such as compulsive behaviour, fearfulness and aggression (Wiseman *et al.*, 2001). Dogs suffering from osteoarthritis also show a compensatory gait, reducing the load on the affected

elbow. A weight-shift to the contralateral front leg and diagonal hindlimb occurs. The changes in gait and weight distribution might lead to overloading of the non-affected extremities, causing further harm (Bockstahler *et al.*, 2009). Guide dogs need to be a reliable guide and support for the daily activities of their owners. The change in behaviour and overloading of non-affected extremities might further decrease the function of an affected guide dog.

The lack of curative therapy for CED increases the importance of prevention and the selection of dogs for training. In New Zealand, the Blind Foundation Guide Dogs (BFGD) is using a scoring scheme introduced by the New Zealand Veterinary Association (NZVA) in 1992 to screen for radiographical signs of CED (Worth *et al.*, 2010). The BFGD uses the screening (Table 1) as a part of their selection of dogs for guide dog training. Training is an expensive process and the BFGD has limited training spots. It is the goal of the BFGD to have guide dogs in service for as long as possible. It is currently unknown how severe the impact of CED is on the population of guide dogs. Also, the BFGD is uncertain about the effect of a higher grade on the NZVA Elbow Dysplasia scheme on the serving time of these guide dogs. Currently, their training population has a lot of B and 1 grades. It is unknown if these dogs suffer more from CED-related problems or have a shorter career as a guide dog.

Table 1. Grades of the New Zealand Veterinary Association Elbow Dysplasia scheme

Grade	Features
Non-dysplastic[a]	
0	No evidence of elbow dysplasia. This is the optimum grade
B (borderline)	Subtle changes are seen on radiographs of the elbow, that are suggestive of elbow dysplasia but are of insufficient severity to be conclusive
Dysplastic	
1	Mild arthrosis (osteophytes up to 2 mm); further divided into 1a (0–1 mm) and 1b (>1 but <2 mm)
2	Medium arthrosis (osteophytes 2–5 mm)
3	Severe arthrosis (osteophytes >5 mm) or primary lesion (UAP, OCD, FCP)

[a] Dogs scored either 0-0, 0-B or B-B for the two elbows and >1 year of age (or 2 years of age if scored prior to 2004) are accredited free of elbow dysplasia. Dogs with a grade of ≥1 in any elbow are not eligible for accreditation, and are considered dysplastic

UAP = ununited anconeal process; OCD = osteochondritis dessicans, FCP = fragmentation of the medial coronoid process

(Source: Worth et al, 2010)

The aim of this study is to retrospectively investigate the prevalence of CED in this population of guide dogs and investigate if there is a correlation between elbow grade and serving time, in order to answer the question if dogs with a B or 1 on the NZVA Elbow Dysplasia scheme should be excluded from training.

2. Materials and method

2.1. Animals

All dogs have been retrospectively selected from data provided by the BFGD. Dogs with missing data, as described later in data collection, have been excluded. Each dog has been phenotypically graded from 45° flexed mediolateral radiographs of both elbows by a single observer using the NZVA elbow dysplasia scoring scheme (Table 1). All dogs selected for this research are Labrador Retrievers. Neuter status, diet and level of exercise were not recorded. Guide dogs in New Zealand visit a veterinarian at least every six months, with a written veterinary report available for each visit. The veterinarians are all based in New Zealand, their certification is not noted in the database but all are registered with and approved by the Veterinary Council of New Zealand and are qualified to practice veterinary medicine in New Zealand.

2.2. Data collection

The data collected for each dog consisted of gender, date of birth, date of radiographs taken for accreditation, NZVA elbow grades, signs of lameness in the veterinary reports, a diagnosis of CED if available and status of the dog when last seen by a veterinarian. NZVA Elbow grades were rescored to current standards by a single Orthopedic Specialist. Elbow grades were divided into an ordinal scale. The elbows with a NZVA elbow grade of 1, 1a and 1b were assigned to the group NZVA elbow grade 1, in order to prevent the formation of multiple small groups. For this study, a dog was considered positive for CED when a veterinarian reported symptoms of front limb lameness or front limb pain, with a definite diagnosis of CED supported by radiographs. The status of the dogs at the end of the study was divided into a categorical scale (0: Alive and still working, 1: Retired or Withdrawn from the programme, 2: Deceased, 3: Sold abroad, 4: Positively identified for CED).

2.3. Data analysis

All statistics were performed using SPSS Statistics (version 25, IBM Analytics, 2017). Age in days was calculated at the time point the data collection was completed at the 31st of July, 2014. If the BFGD database showed a date of death, this was used to calculate the age in days instead. Serving time was calculated using the date of first radiographs taken as a starting point.

As for the end point; if the status of the dog is alive and working at the time point the data collection was completed, the 31st of July, 2014 was used as the final date. For the other dogs, date of withdrawal from the program or date of the sale were used.

Descriptive statistics were performed on gender, age, serving time and elbow grade. Laterality, the frequency of having the same grade in both left and right elbow, was also checked for each dog. The dogs were then grouped by highest elbow grade (when comparing left and right) and a survival analysis was performed using the Kaplan-Meier curve for the following groups: elbow grade 0, B, and 1. The elbow grade of 2 was excluded due to the low sample number of dogs with this grade. The serving times of the different elbow grades were compared using a Logrank test for significance, with a p-value of <0,05 determined as “significant”. In order to compare serving time of the CED negative and CED positive dogs, another Kaplan-Meier curve was used for the following groups: tested positive for CED and not tested positive for CED. The serving times were compared using a Logrank test for significance, with a p-value of <0,05 determined as “significant”.

The difference in gender ratio between CED positive and negative dogs was further investigated using a Fisher Exact test due to the small sample size of the CED positive group. A p-value of <0,05 was determined as “significant”.

3. Results

3.1. Descriptive statistics

214 dogs were initially included in this study. 190 dogs were selected for analysis, 24 dogs were excluded due to an incomplete data profile (as specified in data collection) in the BFGD database. The gender ratio was approximately 2:1, with 62,6% of the dogs being female and 37,4% male.

The elbow grades were distributed as shown in table 2, indicating that at one year of age, 58,4% of the population shows no or inconclusive signs of osteoarthritis and 41,1% shows mild signs of osteoarthritis (according to the NZVA Elbow Dysplasia scheme). The distribution of the status of a dog at the time point of data collection was 31,1% alive and working, 45,3% retired, or withdrawn, 13,2% deceased, 6,8% sold abroad, and 3,7% diagnosed with CED.

Table 2. Distribution of elbow grades

Elbow grade	Number	Percentage	Cumulative percentage
0	115	30,3%	30,3%
B	107	28,1%	58,4%
1	156	41,1%	99,5%
2	2	0,5%	100%

The distribution of 380 elbow grades scored at time of accreditation for the 190 dogs used in our statistical analysis. A grade of 0 means having no evidence of CED, a grade B (or Borderline) means subtle but inconclusive changes on the radiographs, a score of 1 or 2 means visible signs of arthrosis with osteophyte sizes of 0-1mm and 2-5mm respectively.

Age ranged from 435 to 5789 days, with a mean of 2191 days (standard deviation 1492 days). The serving time ranged from 39 days to 5383 days. The mean for serving time was 1766 days (standard deviation 1493 days)

When checking for laterality, in 73,2% of the cases the grade of the left elbow was equal to that of the right elbow. the variation in laterality between elbow grades was 79,1%, 59,8% and 78,8% for the grades 0, B and 1 respectively, indicating that the formation of osteophytes didn't

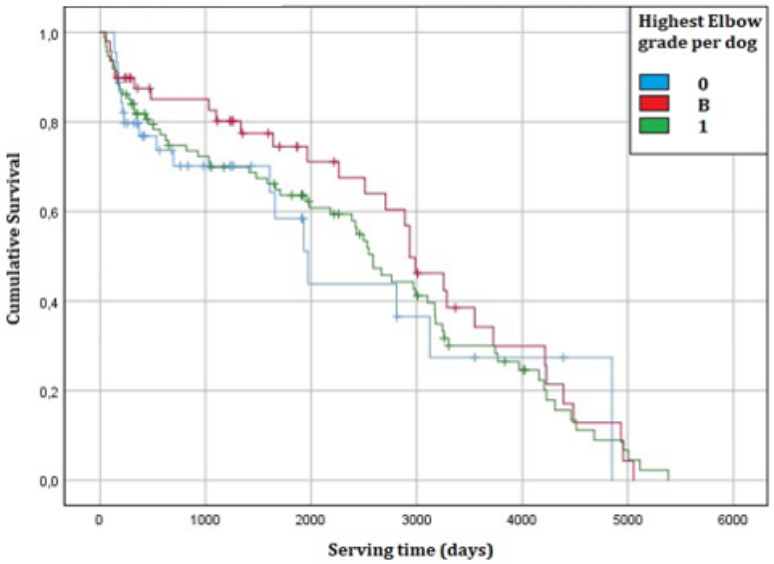
The group of CED positive dogs consisted of 7 animals, 5 of which were male. 3 elbows were graded as B, 10 elbows were graded as 1 and 1 elbow was graded as 2. This indicates that in this population, none of the affected dogs had an NZVA elbow grade of 0 at the age of 1 year, indicating the elbow is generally higher in CED positive dogs. The age of this group ranged from 481 to 3675 days. The mean age was 1051 days (Standard deviation 1160 days). The mean of days served for this group was 559 days (Standard deviation 1155 days), with a range of 51 to 3170 days, indicating a lower mean serving time and upper range when compared to CED negative dogs. However, the group of CED positive dogs is very small and caution is advised when interpreting the results that include the CED positive dogs as a separate group.

3.2. Inferential Statistics

The survival analysis of the CED negative dogs showed a mean estimated serving time of 2385 days (95% confidence interval 1634-3135) for dogs with a highest Elbow grade of 0. For the group of dogs with a highest grade of B, the mean estimated serving time was 2860 days (95% confidence interval 2359-3362). For elbow grade 1, it was 2482 days (95% confidence interval 2118-2846). A Log Rank significance test was run to compare the different groups. The resulting Chi-Square value of 0,87 with a p-value of 0,647 indicates no significant difference in serving time between these groups (Figure 1). The Kaplan-Meier curve for CED negative and CED positive dogs (Figure 2) shows the difference in serving time between these groups. The estimated mean serving time for CED positive dogs is 1258 days (95% confidence interval 176-2340), for CED negative dogs it was 2610 days (95% confidence interval 2335-2884). When calculating the

Logrank test for significance, the resulting Chi-Square value of 7,01 with a p-value of 0,008 shows a significant difference in serving time. When comparing the ratios of male to female in the CED positive and negative groups, the Fishers Exact test shows an exact p-value of 0,105 (2-sided) and 0,069 (1-sided). This shows a tendency to be significant, indicating the difference in ratios might be statistically significant when more data is available.

Figure 1- Kaplan-Meier curve comparing the different NZVA Elbow grades (N=188)



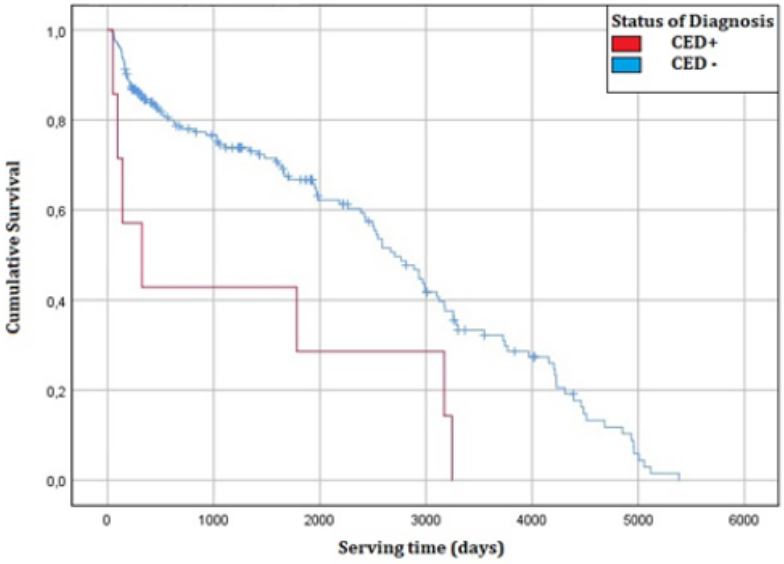
A Kaplan-Meier curve showing the serving time for different elbow grades. For this comparison, the highest elbow grade was chosen per dog. Mean serving time for group 0 (blue) was 2385 days (95% confidence interval 1634-3135), group B (red) had a mean serving time of 2860 days (95% confidence interval 2359-3362) and group 1 (green) 2482 days(95% confidence interval 2118-2846). When calculating the Log Rank test of significance, the resulting Chi-Square value of 0,87 with a P-value of 0,647 indicates no significant difference in serving time between the different groups.

4. Discussion

The purpose of this study was to see if guide dogs with a higher grade on the NZVA Elbow Dysplasia scheme have a shorter serving time and should therefore be used more apprehensively. The data showed no significant difference in serving time when comparing the different NZVA Elbow grades. As such, this indicates that a higher NZVA elbow grade is not an indication for a shorter serving time. However, when comparing CED negative and positive dogs based on diagnosis with clinical signs and radiographs, the serving time for CED positive dogs was significantly shorter by an average of 3.3 years.

The prevalence of CED in our study population of 3,7% is similar to other studies. A population of UK Labrador Retrievers had a prevalence of 17% while Lavrijsen *et al.* reported a prevalence of 5,2% in 5033 evaluations amongst 6

Figure 2 – Kaplan-Meier curve comparing CED positive to CED negative dogs (N=190)



A Kaplan-Meier Curve showing the serving times of CED positive(red) and CED negative (blue) dogs. CED positive dogs had a mean estimated serving time of 1258 days (95% confidence interval 176-2340), while CED negative dogs have an estimated mean serving time of 2610 days (95% confidence interval 2335-2884. When comparing two curves, the Log Rank test for significance, the resulting Chi-Square value of 7,01 with a p-value of 0,008 shows a significant difference in serving time.

different Retriever breeds. Interestingly, the prevalence of OA without primary disease was 2,9% (Morgan *et al.*, 1999; Morgan *et al.,* 2000; Lavrijsen *et al*, 2012); a possible reason for the lower prevalence in our study is pre-selection of guide dogs for accreditation. It was hypothesized that dogs showing clear signs of front limb lameness before 1 year of age will most likely not be presented at one year of age for screening, which leads to an underrepresentation of CED positive dogs.

The effects of health conditions on working dogs has been studied before. A study by Caron-Lormier *et al.* showed a withdrawal rate of 28% in UK working dogs. Our study showed a withdrawal rate of 45,3% which is considerably higher. However, this percentage included the dog who retired and data was not collected in a way to differentiate the retired dogs due to specific other reasons or just old age. This is something which could be specified in future studies. The mean serving of retired dogs in the study of Caron-Lormier *et al.* was 3119 days (standard error 8.36), which is considerably longer than our mean serving time of 1766 days. However, our population included numerous dogs who are still active, leading to a lower mean serving time. In New Zealand, the BFGD starts looking for a replacement dog once the previous dog reaches 9 years of age. The aimed age of retirement is 11 years. The largest group of health conditions leading to early retirement were related to arthritis (45% of withdrawal cases). This does show a noted decrease in serving time. However, the location of the arthritis was not specified and the study included multiple breeds and crossbreeds, not just Labrador Retrievers (Caron-Lormier *et al.*, 2016). Similarly, our study showed a noted decrease in serving in dogs with osteoarthritis (the CED positive population).

It was interesting to see that the group of CED positive dogs, had a seemingly significant overrepresentation of male dogs. This was not expected, as the ratio of female to male dogs in the total study population was approximately 2 to 1. The Fishers Exact test showed a tendency for significance, warranting more research into this subject. Lavrijsen *et al.* found a similar sex predisposition with male Labrador Retrievers, with a male to female ratio of 1.5:1 (Lavrijsen *et al.*, 2014). It is possible that difference in gender, such as juvenile skeletal development, weight gain during growth or hormone levels make male dogs more susceptible (Lavrijsen *et al.*, 2014). The general gender ratio might be a result of the breeding programme of the BFGD. Their aim is to select more female dogs as to complete more breeding assessments, which includes the elbow radiographs. Traditionally, there is a belief that female dogs are more suitable as guide dogs (Goddard *et al.*, 1982), but the BFGD claims to not select on sex for this purpose.

There are several limitations to this study and its design. The data was collected retrospectively, which means the records were not specifically designed for this study, leading to a lower quality of data or missing data. Also, the level of expertise of the veterinarians who examined the dogs was unknown, which could indicate that subtle signs of CED could be missed. Furthermore, the single 45° flexed mediolateral radiographs of both elbows used for grading is less than the recommendation of the IEWG and might lead to an underdiagnosis of ED. Lappailanen *et al.* showed in the Finnish scoring system that by adding a craniocaudal radiograph the amount of correct diagnosis increased compared to a CT-scan, especially concerning the medial humeral epicondylar osteophytes (Lappailanen *et al.*, 2013; Cook *et al.,* 2009). Without this projection, problems in the medial condyle area, such as osteophytes or Osteochondrosis, could be missed. The addition of this projection could have merit in the screening as the amount of false negative dogs would be less. Another issue is the short follow-up for some of our dogs, i.e. 25% of the dogs is 24 months or younger. All dogs are followed for multiple years, as the development of clinical signs CED could take several years (Vermote *et al.*, 2010). When comparing the CED positive and negative dogs in this population, a third of the CED negative population has not been

followed to the average age of diagnosis in this study, i.e. 47 months. Thus, it is possible that several of these dogs will develop clinical signs of CED in the future.

With an outlook towards the future, in order to support the preferable retirement age of 11 years, more information about this population is needed. In the present study, the prevalence of low NZVA grades (0, B, or 1) was considerably higher than the prevalence of high NZVA grades (2 or 3). The reason for this might be a pre-selection of dogs who apply for accreditation. To show a more realistic prevalence of CED in the population dogs should be followed from birth, not just from accreditation and for a longer period of time.

This study shows no significant difference in serving time for guide dogs with a NZVA elbow grade of 0, B or 1. These results suggest that dogs with a grade of B or 1 are just as viable for guide dog training as dogs with a NZVA elbow grade of 0. Future research could focus on following guide dogs for longer periods of time, with a more standardised method of diagnosing CED to improve the quality of the data. Alternatively, more research is necessary to investigate the sex inequality of CED positive dogs, as this research did not have enough CED positive dogs to make any viable conclusions.

Conflict of interest

None.

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