Characterization and prevalence of cataracts in Labrador Retrievers in The Netherlands

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Objective—To assess the prevalence and distribution of types of cataract, investigate the effects of selective breeding on cataract development, and identify the relationship between posterior polar cataract and other types of cortical cataracts in Labrador Retrievers in The Netherlands.

Animals—9,017 Labrador Retrievers.

Procedures—Records of 18,283 ophthalmic examinations performed by veterinary ophthalmologists from 1977 through 2005 were reviewed. There were 522 dogs affected by hereditary cataracts in 1 or both eyes without progressive retinal atrophy (PRA) and 166 PRA-affected dogs with cataracts. These cataracts were divided into 3 groups: posterior polar (triangular) cataract, extensive immature and mature cataract, and a miscellaneous group. Dogs with PRA were analyzed separately.

Results—From 1980 through 2000, the prevalence of hereditary cataracts was stable at 8%. The prevalence of cataracts in offspring of cataract-affected dogs was significantly increased, compared with the prevalence in offspring of nonaffected dogs. The distribution of types of cataract was significantly different between dogs with primary cataract and PRA-affected dogs. Dogs with posterior polar (triangular) cataracts produced affected offspring with the same distribution of types of cataracts as the entire population of primary cataract-affected dogs.

Conclusions and Clinical Relevance—Cataract development in the Labrador Retriever population in The Netherlands appears to be a predominantly genetic disorder. Posterior polar (triangular) cataracts appear to be related to other types of hereditary cataract. Although there is no conclusive evidence, it seems valid to continue exclusion of all Labrador Retrievers affected by any type of primary cataract from breeding. (Am J Vet Res 2008;69:1336–1340)

In Labrador Retrievers, several different types of cataract may develop, most of which are assumed to be phenotypic variations of the same genetic disorder.1,2 In this breed of dog, 50% of PPCs are detectable by 2 years of age.3 In a study of 1,399 Labrador Retrievers, 5.5% were affected by cortical cataracts (most commonly PPCs).4

Dogs that belong to members of the Dutch Labrador Club must undergo an ophthalmic examination performed by an ECVO-accredited examiner prior to breeding. According to the Dutch Labrador Club regulations, both dogs of a breeding pair must have a current ophthalmic report (ie, examination must have been performed within the year prior to birth of the litter).3 If a dog is affected by cataracts or another ophthalmic disease that is presumed to be inherited, it is excluded from the Club’s breeding program.

It has not yet been proven that PPC development is genetically related to the other types of cataract in Labrador Retrievers, but it has been suggested that it is likely.5 Also, it has not been elucidated whether PPC is a progressive condition. Some breeders regard PPCs as a stationary disorder without visual impairment and accept inclusion of affected dogs in the breeding population. However, extensive progression of posterior polar subcapsular cataracts in 8 of 40 (20%) Labrador and Golden Retrievers has been reported.6 In Entlebucher Mountain dogs, the frequency with which this type of cataract develops into cataracts that cause visual impairment is 8%.7 For the Labrador Retriever population in The Netherlands, no information on the progression of PPCs is available because affected animals only rarely undergo ophthalmic reexamination.
Hereditary retinal degeneration or PRA in dogs is known to be often complicated by cataract development. This is most likely associated with changes in the vitreous humor, secondary to degeneration of the retina, which lead to a change in the nutritional supply of the lens. The metabolism of the lens is subsequently altered, thereby resulting in the development of cataracts. The initial changes typically occur in the posterior cortex. The incidence of secondary cataract in dogs with PRA is yet unknown.

The purpose of the study reported here was to assess the prevalence and distribution of types of cataract, investigate the effects of selective breeding on cataract development, and identify the relationship between PPCs and other types of cortical cataracts in Labrador Retrievers in The Netherlands.

Materials and Methods

From 1977 through 2005, 18,283 ophthalmic examinations were performed in 9,017 Labrador Retrievers in The Netherlands. From 1996 until 2004, > 80% of the breeding stock was examined.

The examiners were trained and the examinations performed according to guidelines of the ECVO scheme against presumed inherited ophthalmic diseases, which was established in 1992. Prior to establishment of the scheme, the same guidelines were applied in The Netherlands. Pedigrees of all examined dogs were obtained, and the identity of each dog was confirmed on the basis of its tattoo or microchip number.

Ophthalmic examination—As a standard procedure, the pupils of each dog were dilated via topical administration of 0.5% tropicamide 20 minutes before the examination. In a darkened room, slit-lamp biomicroscopy and indirect ophthalmoscopy of both eyes were performed. For cataracts and retinal degeneration, the 3 possible classifications were unaffected, affected, or suspicious; the latter classification was made if the dog had minor but specific signs of the disease and if further progression over time would possibly lead to confirmation of the diagnosis. A reexamination in 6 to 12 months was recommended for dogs that were classified as suspicious. For each hereditary disease, the dogs received 1 classification, regardless of whether 1 or both eyes were affected. The results of the ophthalmic examination, which included a drawing of the dimension of the cataracts, were provided on certificates that were designed for this purpose. Since 1992, the official ECVO eye certificate has been available for use, and archived copies of these certificates were reviewed in the study.

In 2004, a scheme for classification of cataracts in 5 categories was adopted; the categories were cortical, posterior polar, anterior suture line, punctata, and nuclear cataracts. Prior to adoption of this scheme, cataracts were described and images were drawn according to the same categories.

On the basis of findings of the ophthalmic examination, dogs with cataracts or other inherited ophthalmic diseases were excluded from the breeding population, according to the rules of the Dutch Labrador Club. Dogs with PRA were excluded from breeding as well as their parents and offspring, until a DNA marker test for prcd-PRA became available in the 1980s and the breeding advice could be refined.

Data handling and analysis—At the time of the study, the Dutch Labrador Club used a software program2 to handle the pedigree data of > 110,000 Labrador Retrievers and their available health data. For analysis, 18,283 records of eye examinations performed on 9,017 dogs were available. All eye examination records in the database were checked for accuracy before the data regarding cataracts were retrospectively evaluated. If dogs underwent more than 1 ophthalmic examination, the final one was used in this study.

Because PRA is frequently complicated by cataract development, dogs with PRA (n = 262) were excluded from the analysis regarding hereditary cataract development. The data from the remaining 8,755 Labrador Retrievers were analyzed. For 6,276 of the examined dogs, the results of ophthalmic examinations of their parents were available as well.

For evaluation purposes, the hereditary (mostly cortical) cataracts were classified as 1 of 3 types as follows: type I = PPC; type II = extensive immature and mature cataract; and type III = miscellaneous, including anterior suture line, punctata, cortical, and nuclear cataracts. The distribution of the types of cataract in dogs with and without PRA was compared by use of the χ² test for trends. Differences in incidence of cataract development among offspring of cataract-affected and nonaffected parents were also evaluated by use of the χ² test for trends.9

For all analyses, a value of P < 0.0001 was considered significant.

The results of matings between cataract-affected and nonaffected dogs were calculated with a 95% confidence interval by use of an equation as follows:

\[ p \pm 1.96\sqrt{\frac{p(100-p)}{N}} \]

where \( p \) is the percentage of cataract detected in the sample, and \( N \) is the sample size.

Results

Data were available for 9,017 Labrador Retrievers, of which 262 had PRA. For most analyses, data for dogs with PRA were excluded and analyzed separately. Of the remaining 8,755 non–PRA-affected Labrador Retrievers, 322 had cataracts; cataract-affected dogs included 331 females (5.85% of 5,997 female dogs without PRA) and 171 males (6.20% of 2,758 male dogs without PRA).

Dogs with a cataract classification of suspicious (n = 112) were, for evaluation purposes, regarded as affected because the records indicated that of 193 dogs (PRA-affected Labradors included) that were classified as suspicious and reevaluated, 160 (83%) were diagnosed as affected at reexamination.

Of the 322 animals affected with cataracts, 204 could not be classified because in the earlier portion of the examination program, the type of cataract was not sufficiently recorded. Before 1980, only the examination forms of dogs affected by hereditary ophthalmic...
disorders were preserved. Therefore, the prevalence of cataracts in this period seemed extremely high in our data (23.5%) and was not used in the analysis of prevalence.

The age at which cataracts were initially diagnosed ranged from 6 months to 9 years. At the age of 4 years, cataracts were identified in only 63% (327/522) of affected dogs; at the age of 5 years, cataracts were identified in only 75% (392/522) of affected dogs (Figure 1). The analysis was repeated on the data for only affected dogs ≤ 36 months old and older dogs that were affected but had been free of cataracts in the previous year; the authors expected this to give a more accurate description of the age of onset of cataracts, but results indicated approximately the same distribution pattern.

To avoid underestimation of the prevalence of cataracts at the time of the study, the data from dogs born after 2000 were not used in drawing conclusions regarding changes in the prevalence with time (Figure 2). In the period from 1980 through 2000, the overall prevalence of cataracts (including PRA-affected dogs) decreased from 18% to 8%. When PRA-affected dogs—including a large number of dogs with secondary cataracts—were excluded from the assessment, the percentage of dogs with cataracts was stable at 8% over that interval.

In the period from 1977 through 2005, the overall prevalence of cataracts among the 8,755 non–PRA-affected dogs was 5.96%. The most common type was PPC, which comprised 76.8% of classified cataracts (Table 1).

Of 262 dogs that were classified for PRA as affected (n = 219) or suspicious (43), 166 (63.4%) had cataracts and another 5 (1.9%) were classified as suspicious for cataracts. This group contained 90 female and 81 male dogs. Only 113 of the 171 Labrador Retrievers with both PRA and cataracts could be classified (Table 1). Within that group, all types of cataract were evident, but their distribution was significantly (χ² test for trends, P < 0.0001) different from that in dogs that were not affected by PRA.

For 6,276 dogs, the results of ophthalmic examinations of both parents were available. After exclusion of PRA-affected animals (n = 104) and also dogs with 1 or both parents affected by PRA (74), data from both parents of 6,098 dogs remained for further analysis. Among these 6,098 dogs, 5,771 were classified as unaffected with cataracts and 327 were classified as affected with cataracts; at the age of 5 years, cataracts were identified in only 75% (392/522) of affected dogs (Figure 1). The analysis was repeated on the data for only affected dogs ≤ 36 months old and older dogs that were affected but had been free of cataracts in the previous year; the authors expected this to give a more accurate description of the age of onset of cataracts, but results indicated approximately the same distribution pattern.

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![Figure 1](image1.png)

**Figure 1**—Distribution of ages at which a diagnosis of cataracts was made in 522 of 8,755 non–PRA-affected Labrador Retrievers in The Netherlands during ophthalmic examinations performed as part of a prebreeding screening program in the period 1977 through 2005.

![Figure 2](image2.png)

**Figure 2**—Percentage of cataract-affected dogs by year of birth among 9,017 Labrador Retrievers in The Netherlands (with or without PRA; gray bars), compared with the percentage among 8,755 dogs after exclusion of 262 PRA-affected animals (striped bars) that underwent ophthalmic examination as part of a prebreeding screening program in the period 1980 through 2005.

Table 1—Distribution of types of cataracts in 318 non–PRA-affected and 113 PRA-affected Labrador Retrievers in The Netherlands for which cataract classification was recorded as part of ophthalmic examinations performed from 1977 through 2005. Among 8,755 non–PRA-affected dogs that underwent ophthalmic examination during this period, 522 had cataracts but classification of type was not available for 204 dogs; among 262 PRA-affected dogs, 171 had cataracts but classification of type was not available for 58 dogs.

<table>
<thead>
<tr>
<th>Type of cataract</th>
<th>Non-PRA-affected dogs (%)</th>
<th>PRA-affected dogs (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>244 (76.8)</td>
<td>29 (34.5)</td>
</tr>
<tr>
<td>II</td>
<td>22 (7.2)</td>
<td>25 (22.1)</td>
</tr>
<tr>
<td>III</td>
<td>51 (16.0)</td>
<td>49 (43.4)</td>
</tr>
<tr>
<td>Total</td>
<td>318</td>
<td>113</td>
</tr>
</tbody>
</table>

Data are presented as number of dogs (%).

*Hereditary (mostly cortical) cataracts were classified as 1 of 3 types as follows: type I = PPC; type II = extensive immature and mature cataract; and type III = miscellaneous, including anterior suture line, punctata, cortical, and nuclear cataracts.
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The mode of inheritance of cataracts is yet unknown. There have been suggestions by some authors, but there are no published reports that provide conclusive evidence for any genetic model, to our knowledge. Even data obtained from the substantial group of dogs included in the present study did not provide any insight on this matter. Therefore, only cataract-affected dogs should be excluded from breeding and not their parents.

Facts that are apparent from the study of this report are that cataract development is at least a partially late-onset disease and that only approximately a third of affected dogs are detected at an age before breeding starts (ie, < 2 years of age). This aspect of the disorder seems to be important in explaining the poor result of the selection program. However, selective breeding might have been helpful in keeping the prevalence of cataract limited among the dogs in the present study.

In family groups, all types of cataract developed; therefore, these cataract types cannot be considered totally separate entities. It could mean that the types of cataracts assessed in the present study are phenotypic variations of the same genetic mutation or mutations, but it is also possible that there are different genetic mutations that occur simultaneously in the Labrador Retriever population in The Netherlands.

In the present study, the distribution of cataracts in the offspring that had 1 or both parents affected by type 1 cataracts was similar to the distribution in the general population of dogs affected by hereditary cataracts. The number of dogs per phenotypic group (per cataract type) was limited, so there was no conclusive evidence, but it does appear that all types of cataract are part of 1 genetic disorder with different phenotypic expressions.

Labrador Retrievers affected by both PRA and cataracts were regarded as a separate group in our study. The data collected from these dogs indicated that at least 63% of the dogs with PRA had developed cataracts at the moment PRA had been diagnosed. However, affected dogs were rarely returned for reexamination by an ECVO-accredited ophthalmologist. It is highly probable that the number of PRA-affected dogs that have cataracts is distinctly higher if assessed at a later stage of PRA.

In addition to a much higher frequency of cataract development, the distribution of the types of cataracts in PRA-affected dogs was significantly different from the distribution for all other dogs with cataracts. This suggests that PRA-affected dogs developed cataracts via a different pathogenic pathway than the other dogs in the study population. The reason for this is most likely the altered nutritional supply of the lens.

The data from the present study suggest that cataract development in Labrador Retrievers in The Netherlands is a predominately genetic disorder. Posterior polar (triangular) cataracts appear to be genetically related to the other types of cataract. At least, there were no indications that 2 genetic disorders, 1 causing PPCs and another causing other types of cataract, were in effect in the study population. Because of this lack of evidence that PPCs are a completely separate entity and

Table 2—Distribution of types of cataracts in 35 non–PRA-affected Labrador Retrievers in The Netherlands for which classification of the type of hereditary cataract in at least 1 parent and these offspring had been recorded as part of ophthalmic examinations performed from 1977 through 2005. Among 8,755 non–PRA-affected dogs that underwent ophthalmic examination during this period, 318 had type-classified cataracts; however, for 283 dogs with 1 or 2 cataract-affected parents, classification data were not available for either parent.

<table>
<thead>
<tr>
<th>Cataract type*</th>
<th>Among parent dogs</th>
<th>Cataract type*</th>
<th>Among offspring</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>I</td>
<td>22</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>II</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>III</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td>2</td>
<td>7</td>
</tr>
</tbody>
</table>

Data are presented as number of dogs. See Table 1 for key.

(P < 0.0001). Mating combinations of 2 affected parents resulted in 24 dogs, 4 of which were classified as affected (2 Labrador dogs were unaffected); the percentage of affected offspring from this type of mating was 16.67% (95% confidence interval, 1.76% to 31.58%). The difference in percentages of affected offspring derived from matings involving 1 or 2 affected parents was, however, not significant.

Among the 6,098 dogs for which ophthalmic data from both parents were available, classification of the type of hereditary cataract in at least 1 parent and offspring had been recorded for 35 dogs (Table 2). All 3 types of cataract were detected among offspring produced by matings involving at least 1 PPC-affected parent. The distribution of the 3 types of cataracts in these offspring was similar to that in all the non–PRA affected dogs (Table 1).

Discussion

In the present study, the prevalence of cataracts in offspring from 1 cataract-affected parent was significantly greater than that in offspring of 2 nonaffected parents, which strongly suggests that cataract development in Labrador Retrievers in The Netherlands is predominantly a genetic disorder.

Because PPCs can develop in dogs that are at least 9 years old, potentially some affected dogs may not have been detected in our study and the increase in prevalence of cataracts in the offspring might even be underestimated given that dogs are only examined yearly while they are part of the breeding program in The Netherlands.

Unlike selection against PRA (the frequency of detection that decreased from 10% to 0.5%) in this population of Labrador Retrievers during this study period, the result of selection against primary cataracts is disappointing. The success of the selection program against PRA (and therefore selection against 1 cause of cataract) mainly resulted from the simple mode of inheritance (autosomal recessive) of PRA in Labrador Retrievers. When the selection program was started in the 1980s, heterozygotes (known carriers of the pred–PRA gene) were excluded from breeding as soon as an affected dog was detected among their offspring. The DNA marker test for pred–PRA that was introduced at the end of the 1990s made selection against PRA in Labrador Retrievers even more effective.

The mode of inheritance of cataracts is yet unknown. There have been suggestions by some authors, but there are no published reports that provide conclusive evidence for any genetic model, to our knowledge. Even data obtained from the substantial group of dogs included in the present study did not provide any insight on this matter. Therefore, only cataract-affected dogs should be excluded from breeding and not their parents.

Facts that are apparent from the study of this report are that cataract development is at least a partially late-onset disease and that only approximately a third of affected dogs are detected at an age before breeding generally starts (ie, < 2 years of age). This aspect of the disorder seems to be important in explaining the poor result of the selection program. However, selective breeding might have been helpful in keeping the prevalence of cataract limited among the dogs in the present study.

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because PPC is not proven to be a stationary disorder, it is valid, in the authors’ opinion, to exclude all Labrador Retrievers with any type of primary cataract from breeding. Further research is needed to elucidate the genetic correlation between PPCs and other types of cataract in this breed of dogs.

References