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Western blot patterns of serum autoantibodies against optic nerve antigens in dogs with goniodysgenesis-related glaucoma

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Abstract

Objective—To investigate whether differences existed between clinically normal dogs and dogs with goniodysgenesis-related glaucoma (GDRG) in serum autoantibodies against optic nerve antigens.

Animals—16 dogs with GDRG, 17 healthy dogs with unremarkable pectinate ligament and iridocorneal angle morphology, and 13 euthanized dogs with no major ocular abnormalities or underlying diseases.

Procedures—Western blotting was performed with optic nerve extracts from the euthanized dogs as an antigen source and serum from clinically normal dogs and dogs with GDRG as a primary antibody (autoantibody) source. Blots were evaluated for presence and density of bands.

Results—Multiple bands were identified on western blots from all dogs with GDRG and all clinically normal dogs, with a high degree of variability among individual dogs. Dogs with GDRG were significantly more likely than healthy dogs to have bands present at 38, 40, and 68 kDa. Dogs with GDRG had significant increases in autoreactivity at 40 and 53 kDa and a significant decrease in autoreactivity at 48 kDa.

Conclusions and Clinical Relevance—Significant differences in serum autoantibodies against optic nerve antigens were found in dogs with versus without GDRG. Although it remains unclear whether these differences were part of the pathogenesis of disease or were sequelae to glaucomatous changes, these findings provide support for the hypothesis that immune-mediated mechanisms play a role in the development or progression of GDRG. However, the high degree of variability among individual dogs and the considerable overlap between groups suggest that the clinical usefulness of this technique for distinguishing dogs with GDRG from clinically normal dogs is likely limited.

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Glaucoma, in dogs, is the equivalent of a terminal disease for the eye. Existing protocols for treatment and prophylaxis are limited in their effectiveness. The disease leads to pain and loss of vision, and removal of the eye is often necessary when the disease becomes refractory to treatment. Goniodysgenesis, or congenital malformation of the aqueous humor outflow pathways, is a major predisposing factor in the development of glaucoma in dogs. Although mechanical obstruction of aqueous humor outflow certainly contributes to an increase in IOP, the midlife onset of GDRG in most dogs suggests that congenital malformations may not be the sole factor underlying the development of disease.^{1,2} Other, acquired pathophysiologic mechanisms may be involved, whether as part of the initial trigger for disease or as amplifying factors once glaucomatous changes have started to develop. Identification of some of these additional mechanisms may improve our ability to identify and treat affected dogs.

Findings in dogs, humans, and laboratory animals suggest that inflammatory and autoimmune processes may play a role in the development or progression of glaucoma.³⁻⁶ In particular, several studies⁷⁻¹⁵ have been performed to evaluate changes in serum autoantibody profiles against retinal and optic nerve antigens in glaucomatous humans, through use of a western blot-based technique with retinal or optic nerve digests as antigen sources. These studies have revealed significant differences, involving both increases and decreases in autoreactivity, between healthy people and people with glaucoma. It remains unclear, as the investigators in these studies have pointed out, whether changes in autoreactivity are part of the underlying pathogenesis of disease or are sequelae to the damage caused by glaucoma. However, the apparent consistency of findings to date supports the legitimacy and potential usefulness of the described method. Similar methodology has been used in studies¹⁶⁻²² of other human immune-mediated disorders, with equally promising results.

We hypothesized that use of a similar western blot technique to evaluate dogs with GDRG would reveal key differences between glaucomatous and healthy dogs and that such differences could serve as the basis for future research and potentially as diagnostic or prognostic tools. The optic nerve was chosen as an antigen source for several reasons. Damage to the axons of the optic nerve occurs prior to loss of retinal ganglion cell bodies in glaucoma.^{23,24} Moreover, neither lowering of IOP nor blockade of apoptotic pathways appears to halt axon loss, although antiapoptotic treatments can protect ganglion cell bodies.^{25,26} Disruption of axonal transport secondary to the increase in IOP occurs in dogs and humans and certainly plays an important role in axonal loss.²⁷ However, given the inconsistent relationship between IOP and axonal damage, the possibility exists that axonal damage may be initiated prior to an increase in IOP. The purpose of the study reported here was to determine whether glaucomatous optic neuropathy in dogs involves immune-mediated mechanisms.

Materials and Methods

Animals

Sixteen dogs with GDRG and 17 healthy control dogs were enrolled in the study. Owner consent for study inclusion was obtained for all dogs. The study protocol was approved by

the Clinical Studies Review Committee of Tufts University Cummings School of Veterinary Medicine. Optic nerves for the study were obtained separately from 13 euthanized dogs that had been donated to the Tufts University Cummings School of Veterinary Medicine for teaching and research use.

A complete ophthalmic examination was performed on all dogs with GDRG and healthy dogs by a board-certified veterinary ophthalmologist or ophthalmology resident, consisting of Schirmer tear testing, fluorescein staining, slit-lamp evaluation of the anterior segment of the eye, indirect ophthalmoscopy, and gonioscopy. All dogs also underwent a CBC, serum biochemical analysis, urinalysis, and general physical examination. Dogs with additional ocular pathological changes, immune-mediated disorders, neoplasia, endocrine disease, or any other potentially confounding condition as determined by history, physical examination, or laboratory findings were excluded. Current or recent (within the preceding 2 months) use of topical or systemic immunomodulatory drugs, including but not limited to corticosteroids, cyclosporine, tacrolimus, tetracyclines, and metronidazole, was also grounds for exclusion.

Dogs in the GDRG group were enrolled from among patients of the ophthalmology service at the Tufts University Cummings School of Veterinary Medicine. Inclusion criteria consisted of a high IOP (> 24 mm Hg as measured by applanation tonometry), gonioscopic evidence of goniodysgenesis in the contralateral eye as judged by a board-certified veterinary ophthalmologist or ophthalmology resident, and loss of vision or fundic changes in the affected eye consistent with glaucoma.² Two dogs included in the GDRG group had previously undergone enucleation for refractory primary glaucoma in the contralateral eye and had signs consistent with primary glaucoma in the remaining eye during the study enrollment period. Gonioscopic evaluation of the normotensive eye at the time of first enucleation had been performed and revealed goniodysgenesis. Additionally, results of histologic evaluation of the previously enucleated globes were consistent with goniodysgenesis-related primary glaucoma in both dogs.

The healthy dogs were selected from among staff-owned pets between 3 and 9 years of age and weighing > 10 kg, with no evidence of pathological changes on ophthalmic examination. All dogs were required to have an IOP between 12 to 24 mm Hg as measured by applanation tonometry.² Gonioscopy was performed by one of the investigators (SAP). All had a healthy, open iridocorneal angle (3+) with no evidence of pectinate ligament dysplasia.²⁸ Euthanized dogs were free of gross ocular abnormalities and had no history of neoplasia, autoimmune disease, or other conditions that might have a confounding influence on the study findings.

Sample collection

Three milliliters of blood was obtained from all dogs with GDRG and all healthy control dogs via jugular venipuncture by use of a 0.5-inch, 20-gauge needle. Serum was separated by centrifugation ($1,315 \times g$), transferred to nonreactive tubes, and held at -80°C until the time of analysis.

Optic nerves were harvested from euthanized dogs within 1 hour after death. Perineural tissues were completely removed, and nerves were trimmed such that no optic nerve head,

retinal, or scleral tissue was included. Optic nerve tissues were then frozen at -80°C until use.

Western blot technique

Sample handling and western blotting were performed in a manner similar to that described in previous reports.^{9–12} Optic nerves were used to provide an antigen source. Previously harvested optic nerves were minced by hand and then homogenized in ice-cold cell lysis buffer containing protease inhibitors (20mM Tris [pH, 7.5], 150mM NaCl, 1mM EDTA, 1mM ethylene glycol tetraacetic acid, 1mM $\text{Na}_4\text{P}_2\text{O}_7$, 1mM β -glycerophosphate, nonionic surfactant,^a 200mM Na_3VO_4 , aprotinin [2 mg/mL], and leupeptin [2 mg/mL]). Pooled extracts were centrifuged and separated from the pellet, then refrozen at -80°C until use. Nerves and extracts were kept chilled at all times during handling to minimize proteolysis. The method of Lowry et al²⁹ was used to determine protein content in the optic nerve extract.

Pooled optic nerve extracts were subjected to 10% SDS-PAGE at 180 V and 500 mA for 1 hour by use of an electrophoresis cell.^b Nerve extracts were first mixed with 2X SDS loading buffer with β -mercaptoethanol at a 1:2 ratio and boiled for 5 minutes. Extracts were loaded at 25 μg of protein/lane, with high- and low-weight molecular markers included on each gel. After electrophoresis, the gels were blotted onto nitrocellulose membranes^c at 30 V overnight by use of a wet blotting method.^d The blots were then blocked for 6 hours with 5% nonfat dry milk in Tris-buffered saline (0.9% NaCl) solution with Tween.

Blots were cut into strips corresponding to lanes. Strips were incubated overnight with serum from the study dogs (diluted 1:100 in blocking buffer) as primary antibody. Strips were then washed multiple times (3×10 minutes) with Tris-buffered saline solution with Tween and finally with Tris-buffered saline solution alone. After the washing stage, strips were incubated with secondary antibody (goat anti-dog IgG^e diluted 1:10,000 in blocking buffer) for 15 minutes. Bands were made visible by reaction with enhanced chemiluminescence reagents followed by exposure to x-ray film.

As a negative control sample, 1 strip/blot was incubated with blocking buffer in the absence of serum, then treated with secondary antibody and enhanced chemiluminescence reagents as described previously. As a positive control sample, 1 strip/blot was incubated with anti-myelin basic protein C-16 IgG in blocking buffer as primary antibody^f (1:200 dilution), then treated with goat anti-human IgG secondary antibody^g (1:5,000 dilution) and enhanced chemiluminescence reagents.

Developed blots were evaluated for overall number of bands as well as presence and density of individual bands. Corresponding molecular weights were assigned through use of

^aTriton X-100, Sigma, St Louis, Mo.

^bCriterion Cell, Bio-Rad, Hercules, Calif.

^cBio-Rad, Hercules, Calif.

^dCriterion Blotter, Bio-Rad, Hercules, Calif.

^eGoat anti-dog IgG, Santa Cruz Biotechnology Inc, Santa Cruz, Calif.

^fAnti-myelin basic protein C-16 IgG, Santa Cruz Biotechnology Inc, Santa Cruz, Calif.

^gGoat anti-human IgG, Santa Cruz Biotechnology Inc, Santa Cruz, Calif.

prestained molecular weight standards. Bands were deemed present on the basis of direct visual inspection of blots as well as lane plots generated with imaging software.^h Bands were deemed to be present when a band was visible on the developed blot and a peak of > 30 U greater than background corresponding to the same molecular weight appeared on the generated lane plot. Band density was determined with imaging software^g and normalized to the entire area under the curve as in previous studies.^{9–12}

Statistical analysis

Statistical analyses were performed with statistical software.ⁱ The number of blots per band was compared between healthy dogs and dogs with GDRG via the Wilcoxon test. Differences between groups in the presence or absence of individual bands were assessed via the Fisher exact test. Densitometry data were evaluated for molecular weights for which a band was present in > 25% of dogs in both the GDRG and healthy control groups. Data were evaluated for normality of distribution via the Shapiro-Wilks test. Densitometric values were then compared via the unpaired *t* test and Wilcoxon test as deemed appropriate. Values of *P* < 0.05 were considered significant.

Results

Animals

The median age of the 16 dogs with GDRG was 7 years (range, 1 to 12 years). Eleven breeds were represented, the most common of which were American Cocker Spaniel (*n* = 4) and Basset Hound (3). Five dogs were castrated males, 4 were spayed females, 3 were sexually intact females, and 1 was a sexually intact male. On initial examination, the median IOP in the affected eye was 51 mm Hg (range, 35 to 70 mm Hg). Twelve dogs were blind in the affected eye, whereas 4 retained some degree of retinal and optic nerve function (menace response, dazzle reflex, or indirect pupillary light reflex present). Median duration of clinical signs of GDRG, as reported by owners, was 5 days (range, 1 to 14 days). Examination of the contralateral, unaffected eye (when present) revealed no relevant abnormalities, with the exception of gonioscopic findings and minor changes not likely to be of relevance to the present study (eg, nuclear sclerosis, iris atrophy, and trichiasis). Schirmer tear test values were considered unremarkable (> 15 mm/60 s).³⁰ Results of clinicopathologic tests were unremarkable for each, providing no evidence of potentially confounding diseases. No evidence of major underlying disease processes was noted on physical examination in any dog.

The median age of the healthy control dogs was 5 years (range, 3 to 9 years). Ten breeds were represented, including 2 each of German Shepherd Dog, English Pointer, Labrador Retriever, and pit bull–type dog. Six dogs were castrated males, 6 were spayed females, 3 were sexually intact females, and 1 was a sexually intact male. Laboratory testing and ophthalmic and physical examinations yielded unremarkable results for all of these dogs.

^hImageJ, version 1.44p, National Institutes of Health, Bethesda, Md. Available at: rsbweb.nih.gov/ij/index.html. Accessed Aug 9, 2011.

ⁱR, version 2.12.1, R Foundation for Statistical Computing, Vienna, Austria. Available at: www.r-project.org/. Accessed Oct 7, 2011.

The median age of the euthanized dogs from which optic nerves were extracted was 5 years (range, 2 to 12 years). Seven were mixed-breed dogs, and 3 were Labrador Retrievers. Each had grossly unremarkable eyes, no history of ocular disease, and no reported history of potentially confounding disease. The most common reasons for euthanasia or death included elective euthanasia because of behavioral concerns ($n = 3$), orthopedic disease (3), and vehicular trauma (2).

Western blots

Multiple bands representing serum autoantibodies against optic nerve tissues were evident on western blots from all clinically normal and GDRG-affected dogs (Figure 1). Dogs with GDRG had a median of 9 bands/blot (range, 6 to 15 bands/blot). Clinically normal dogs had a median of 7 bands/blot (range, 4 to 13 bands/blot). The difference between groups with regard to the number of bands per blot was not significant ($P = 0.33$).

Significant ($P = 0.05$) differences in band presence were evident at 38, 40, and 68 kDa. An apparent difference between groups was also observed at 45 kDa, but the difference was not significant ($P = 0.16$). Dogs with GDRG were more likely than clinically normal dogs to have bands at the 38-, 40-, and 68-kDa positions (Figure 2).

Significant differences in band density were found at 40, 48, and 53 kDa, and the difference at 57 kDa neared significance ($P = 0.06$). The Shapiro-Wilk test detected deviation from a normal distribution only for the 48-kDa band. Given that sample sizes were small, parametric and nonparametric tests were performed to compare groups at each molecular weight. Significance was achieved with the unpaired t test and the Wilcoxon test for the 48- and 53-kDa bands, but differences for the 40- and 57-kDa bands were significant or approached significance only when the unpaired t test was used. Dogs with GDRG had greater autoreactivity (ie, greater band density) than did clinically normal dogs for the 40- and 53-kDa bands and lower autoreactivity than in clinically normal dogs for the 48-kDa band (Figure 3).

Discussion

The present study was conducted to investigate the role of immune-mediated mechanisms in GDRG. Identifying at-risk dogs prior to the onset of glaucoma is inherently difficult, and our study population consisted of dogs with overt clinical disease. Thus, our intent was not to determine whether any differences in western blot patterns between healthy dogs and dogs with GDRG suggested a role for autoantibodies in the initial pathogenesis of disease; were the result of early, transient, subclinical increases in IOP that damages ocular tissues, alters ocular immune privilege, and subsequently contributes to the onset of clinically evident disease; or were the consequence of long-standing glaucomatous changes within the eye of longer duration. Longitudinal follow-up studies may provide more information regarding the temporal relationship between autoantibody changes and onset of glaucoma.

The described western blot technique was effectively used to identify significant differences in electrophoretic patterns of serum autoantibodies against optic nerve antigens between dogs with GDRG and clinically normal dogs. A high degree of variability

between dogs within groups as well as considerable overlap between groups in band numbers and individual band presence and density suggests that this technique would not likely have promise as a diagnostic tool in the clinical setting. The observed differences provide additional support for consideration of immune-mediated mechanisms in the pathogenesis of GDRG in dogs, however, and should serve as a stimulus for future research. In particular, the relationship between changes in autoantibodies and stage of disease requires further investigation, given that the glaucomatous dogs in the present study all had advanced disease.

Although our results established a connection between GDRG and changes in autoantibodies against optic nerve antigens, these results do not allow any conclusions to be made as to whether immune-mediated mechanisms are involved in the initial pathogenesis of disease or are a consequence of established disease that may in turn accelerate or intensify the disease process. Glaucoma, particularly in veterinary patients, has historically been considered a disease of high IOP. However, so-called normal-tension glaucoma, in which characteristic optic nerve and visual field changes occur in the absence of a documented increase in IOP, is well characterized in people.³¹ Conversely, ocular hypertension without glaucoma, in which IOP is high but optic nerve changes and visual field loss are absent, can also develop in people.³² Existence of these 2 disease subtypes serves as a reminder that glaucoma is not purely an aqueous outflow problem, but rather a disease affecting the optic nerve and retinal ganglion cells. High IOP and aqueous outflow obstruction are risk factors for development of disease in people, not absolute requirements. In dogs, normotensive glaucoma has not been documented and high IOP appears to lead consistently to vision loss. However, dogs with goniodysgenesis typically do not develop high IOP or glaucoma until midlife, and many dogs with goniodysgenesis never develop glaucoma.^{1,2} Therefore, congenital malformations are not likely to be the sole factor in development of hypertensive glaucoma in dogs. This realization has prompted the search for additional pathophysiologic mechanisms underlying onset of the disease.

Inflammatory and autoimmune mechanisms may play a role in the development of glaucoma. Glaucomatous globes are commonly removed in veterinary patients, providing considerable histopathologic information regarding glaucoma in dogs specifically. Inflammatory infiltrates in aqueous outflow pathways were identified in most eyes removed because of GDRG in 1 study³³; these changes were not present in control eyes. Similarly, mononuclear cells have been identified in the retina and posterior segment of the affected eye in dogs that have undergone enucleation because of GDRG but not in the eyes of clinically normal control dogs.³⁴ Changes in expression of inflammation-related genes have also been detected in glaucomatous retinas of dogs.³⁵

Research involving laboratory animals has provided additional support for an immune-mediated or inflammatory pathogenesis underlying glaucoma. In models of human pigmentary glaucoma in mice, involvement of bone marrow–derived antigen–presenting cells in development of disease has been demonstrated. Bone marrow ablation followed by rescue with wild-type marrow in these mice prevents glaucoma.^{36–38} Models of disease in rats have been used to establish the potential for T-cell responses to trigger glaucomatous damage to the retina and optic nerve in the presence of high IOP and to show that this

particular type of retinal damage can, in some situations, be triggered by immunization with heat shock proteins in the absence of high IOP.^{39–41}

Circulating autoantibodies against heat shock proteins have also been identified in humans with glaucoma, and exposure to these antibodies can induce apoptosis in cultured retinal ganglion cells.^{42–45} Oxidative stress and transforming growth factor- β 2 expression are both believed to be greater in glaucomatous versus healthy eyes, and are both able to promote expression of heat shock protein-27.^{43,46} Such findings suggest a potential link between inflammation, high IOP, and other forms of cellular stress within the eye and subsequent autoimmunity and retinal and optic nerve damage.

In addition to changes related to heat shock proteins, other immunologic deviances have been identified in humans with glaucoma, involving differences in T-cell subsets and function and alterations in the expression of inflammatory markers and cytokine receptors within the eye and elsewhere.^{47,48} A large number of candidate autoantigens have also been identified in humans with glaucoma, on the basis of presence of serum autoantibodies.^{8–15,43,44,49–54} Given that an increase in the reactivity associated with specific autoantibodies can exist in humans with other autoimmune diseases for extended periods prior to onset of symptoms, this information may be useful in developing screening tools and treatments for glaucoma.^{3,55–57}

Moreover, not only increases but also perhaps decreases in production of specific autoantibodies can be pathological. Autoimmune responses generated in response to insults can in some situations be protective or play a role in reestablishing homeostasis, sometimes via pathways other than typical antigen-antibody interactions.^{3,58,59} Several studies have been performed to evaluate broader patterns of serum and aqueous humor autoantibodies against retinal and optic nerve antigens in glaucomatous humans with digests of those tissues as antigen sources. In people, serum and aqueous humor autoantibody patterns differ significantly between individuals with and without glaucoma and across various categories of disease, including primary open-angle glaucoma, normal-tension glaucoma, and ocular hypertension without glaucoma.^{8–12,14} In those studies, significant and consistent changes consisting of both increases and decreases in autoreactivity have been identified in glaucomatous humans relative to autoreactivity in healthy control subjects. Similar patterns of change have also been found in humans with other diseases believed to have an autoimmune component.^{16–22} In dogs, western blots have been used to screen for retinal autoantibodies in those with SARDS.^{60–62} Use of a western blot–based technique has also been reported once in dogs with glaucoma, although detailed results were not reported.³⁵ To our knowledge, the present study is the first to provide a comprehensive description of western blot–derived autoantibody profiles in dogs with GDRG.

The western blot technique used in our study allows for high-throughput screening for autoantibodies, but it is also necessarily a retrospective technique. The glaucomatous dogs of the present study, like the human subjects of previous studies, were evaluated for changes in autoantibody patterns after the onset of clinically evident disease. Therefore, it was not possible to determine whether the autoantibodies identified had been up- or downregulated because they played a role in disease development or because their expression had been

altered as a response to glaucomatous damage (ie, whether the changes were cause or effect). Even if not a part of the initial pathogenesis of glaucoma, changes in autoreactivity are still of interest because they may serve as an amplifying step, leading to worsening of disease and eventual vision loss. Longitudinal studies involving dogs of at-risk breeds or colonies of purpose-bred dogs with an identified predisposition to glaucoma could potentially allow correlation of autoantibody changes with stage of disease. In particular, tracking dogs with goniodysgenesis over time would provide information regarding the relationship of autoantibody changes to stage of disease.

Glaucoma in dogs is often considered as a single disease process in the clinical setting. When enrolling dogs for the study, we attempted to make our inclusion criteria fairly strict to avoid confounding effects from medications or other disease processes. Only dogs with gonioscopic or histopathologic evidence of goniodysgenesis in the contralateral eye were included. Dogs with glaucoma evaluated during the enrollment period that had unremarkable gonioscopic findings (open angles with unremarkable pectinate ligament morphology) in the contralateral eye were deliberately excluded. However, greater stratification of the study group may yield more significant results, as it has in humans. Comparison of glaucomatous dogs with unaffected dogs within single breeds or, ideally, within single lineages may further our understanding of glaucoma as a diverse group of diseases with shared clinical signs. Future identification of genomic risk factors for canine glaucoma may also allow for greater subtyping of disease and could provide another means for identifying at-risk dogs to follow over time with the western blot technique.

In analogous human studies,^{9–12} electrophoretic bands identified through western blotting have subsequently been analyzed via mass spectrometry, permitting identification of specific autoantigens. Identification of autoantigens was outside the scope of the present study but may provide a basis for future research. Some of the electrophoretic bands identified in our study did potentially align with autoantigens identified in human studies. The 68-kDa band that was more prevalent in the glaucomatous dogs may correspond with heat shock protein-70, autoantibodies against which are greater in amount in humans with glaucoma than in healthy subjects.⁸ The 40-kDa band, which was more likely to be present in dogs with glaucoma than in clinically normal dogs and which, when present, had significantly greater autoreactivity in dogs with glaucoma, may likewise represent annexin V or one of the proteoglycan moieties, which have similar molecular weights and reportedly greater autoreactivity in humans with glaucoma than in healthy subjects.^{13,14}

The 48-kDa band requires some additional attention, given that bands of approximately this molecular weight have been identified in all 3 studies that have been conducted in dogs with SARDS. Interpretation of this band has varied between studies. Gilmour et al⁶⁰ found a 48-kDa band in most SARDS-affected dogs and clinically normal dogs. The band was not present in negative control strips (blots incubated without patient serum but with goat anti-dog IgG), and no additional work was done to identify the underlying retinal autoantigen.⁶⁰ Keller et al⁶¹ detected a band at 50 kDa in all dogs with SARDS and control dogs. In that study,⁶¹ negative control strips, treated similarly to those in the Gilmour et al⁶⁰ study and the present study, also had bands at 50 kDa. This band was found to represent the IgG heavy chain present in the retinal extract. Both canine serum and the purified anti-dog IgG

secondary antibody were reactive against this IgG fragment, thereby explaining the appearance of the band on the negative control strips.⁶¹ Finally, Braus et al⁶² identified a band at 47 kDa that was present in serum from dogs with SARDS but not in serum from clinically normal dogs or on negative control strips. This band was subsequently identified as neuron-specific enolase. Other investigators have also found evidence of autoreactivity at or around this molecular weight in clinically normal dogs.⁶⁰

Although optic nerve tissue rather than retinal tissue was used as the antigen source in the present study and our study population differed, the range of findings at or near this molecular weight in past SARDS studies suggests that some additional caution is required in interpreting our results. Like Gilmour et al⁶⁰ and Braus et al,⁶² we did not detect any bands on our negative control strips, which were also incubated with goat anti-dog IgG. Therefore, this band is unlikely to represent IgG present in our antigen source. Moreover, although we also found the 48-kDa band to be present in serum from all dogs with glaucoma and all clinically normal dogs, a significant difference in band density was evident between the 2 groups, with glaucomatous dogs having less autoreactivity at this molecular weight. The identity of the autoantigen represented by the 48-kDa band is uncertain. Nevertheless, we believe that the changes identified in autoreactivity are a relevant finding.

Overall, we believe that our results provide a basis for further investigations into the role of autoimmunity in the development or progression of canine GDRG. Future work may include following at-risk dogs over time, determining changes within more specific sub-populations of glaucomatous dogs, and evaluating autoreactivity against retinal or trabecular meshwork proteins. Such work may help establish a timeline of events in the pathogenesis of glaucoma and may provide a basis for future screening tools and therapeutic interventions.

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Abbreviations

GDRG	Goniodysgenesis-related glaucoma
IOP	Intraocular pressure
SARDS	Sudden acquired retinal degeneration syndrome

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Figure 1.

Representative western blots from clinically normal dogs and dogs with GDRG. Molecular weight standards are shown at left.

Figure 2.

Distribution of bands in western blots of autoantibodies against optic nerve tissue in serum from clinically normal dogs (n = 17; squares) and dogs with GDRG (n = 16; diamonds).

Notice the extensive overlap between groups with regard to presence of individual bands.

*The number of dogs with a band at the indicated position differs significantly ($P < 0.05$) between groups.

Figure 3.

Mean relative band density in western blots of auto-antibodies against optic nerve tissue in serum from clinically normal dogs ($n = 17$; black bars) and dogs with GDRG (16; gray bars). Relative band density was compared for molecular weights at which $> 25\%$ of dogs in each group had a band present. *Values at the indicated position differ significantly ($P < 0.05$) between groups when compared with the unpaired t test. †Values at the indicated position differ significantly ($P < 0.05$) between groups when compared via the Wilcoxon test.