Breeding Bernese Mountain Dogs to Avoid Degenerative Myelopathy without Negatively Impacting the Gene Pool

The goal…more healthy 10+-year-old dogs pulling carts!

By Pat Long

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Great rear end movement into the double digits! Ruth Nielsen with ten-and-a-half-year-old Tonka the day he earned his Advanced Novice Draft Dog title. BG# 21734. Photo by Laura Lopez Mendez.

What is Degenerative Myelopathy?

Degenerative Myelopathy (DM) is an inherited progressive disease that affects the myelin sheath that covers the nerves of the spinal cord, which interferes with nerve function.

This degenerative disease presents owners of affected dogs with significant management challenges over months to a year or longer course of time. Ultimately DM is fatal. In the Bernese Mountain Dog breed symptoms of DM have been seen as early as six years, which means DM is not only a disease of the older dog. Dogs may not show symptoms until they are 8 to 10+ years of age.

The age of onset for this disease is well after the age at which dogs typically begin to be used for breeding.

Disease Stages

The first symptoms usually consist of unsteadiness in the rear, gradually progressing to an inability to control the back legs. Further degeneration leads to incontinence. In the late stages of the disease dogs experience instability in the front end; and, ultimately the throat is affected which interferes with the dog's ability to eat.

Treatment

There is no treatment for the disease other than managing care for the dog, although there are some supplements and physical therapy measures that may delay the progression to a degree. Caring for an affected dog is emotionally and physically exhausting.

Diagnosis

Diagnosis is one of elimination. Hip dysplasia, intervertebral disc disease, spinal stenosis, and a spinal tumor are some of the diseases that can present similar symptoms. While radiographs and/or an MRI can help rule out some of the other possibilities, the only way to accurately diagnose DM is on necropsy by looking at a stained cross section of the spinal cord. For more information about DM, see www.caninegeneticdiseases.net/DM/basicDM.htm.

A paper published in February of 2017 indicates that levels of a specific protein in cerebrospinal fluid may be promising as a diagnostic tool for symptomatic dogs. See:

www.ncbi.nlm.nih.gov/pmc/articles/PMC5354061/pdf/JVIM-31-513.pdf. At this time (August 2017) the University of Missouri, USA is working to validate the test that is not yet available.

The Genetics of DM

The superoxide dismutase 1 gene, or SOD1, has been linked to degenerative myelopathy (DM).

Breed Specific Tests and Genetics

The Genetic Tests for DM – Bernese Mountain Dogs

- In 2008 a test for a mutation was first used in Bernese Mountain Dogs. That mutation is the SOD1:c.118A, referred to as SOD1-A or exon 2.
- In 2010 a new mutation was discovered in BMDs (and only in BMDs). That mutation is the SOD1:c.52T, referred to as SOD1-B or exon 1.

Two direct DNA tests, one for the A mutation and one for the B mutation, are available that apply to the Bernese Mountain Dog. Many laboratories can perform these two tests, which use DNA from a cheek swab. When the test for SOD1-A is done, a clear result only means that the two genes are clear of that specific SOD1-A mutation; the test for the SOD1-B mutation is necessary to complete the genetic picture. In Bernese it has been determined that the SOD1 gene will have either the A **or** B mutation, not both. If a Berner is at risk for SOD1-A (both copies of the SOD1 gene have the A mutation), then the DNA test for the SOD1-B mutation does not need to be done, and vice versa. If a Berner is clear or a carrier for one of the mutations, then the test for the other mutation must also be done in order to learn the actual status for both copies of the SOD1 gene.

Inheritance

DM is inherited as an autosomal recessive trait with incomplete penetrance. Recessive means that both copies of the gene present in an individual dog have to contain a mutation. In other words, both the mother and father of the dog pass on this mutation to the offspring. The SOD1 gene is not located on the X or Y sex-chromosomes, it's on an autosomal (not sex linked) chromosome.

If a dog gets two mutated SOD1 genes (one from each parent), then that dog is said to be **at risk** for DM. Because not all of the **at risk** dogs will become affected, the trait has incomplete penetrance.

Researchers do not yet know why some at risk dogs get DM and some don't.

- Perhaps tested dogs determined to be **at risk** don't live long enough to show the symptoms.
- Perhaps there are other genes that cause the disease to be triggered, or that cause the disease to be suppressed.
- Perhaps environmental factors play a role.
- We don't know what percentage of Berners tested shown to be **at risk** will become affected, and this percentage is likely to vary by breed.

Statistics – Prevalence of SOD1A and SOD1B Clear and Mutations in DM Tested BMDs

Table 1. Contains the cumulative test statistics from GenSol as of June, 2017.

TEST	CLEAR		CARRIER		AT RISK		TOTAL TESTED	Percentage of Mutations
SOD1A	1438	45.6%	1460	46.3%	253	8.0%	3151	31.2%
SOD1B	2291	87.9%	310	11.9%	5	0.2%	2606	6.1%

As the GenSol data shows, well over half of the dogs that have been tested carry at least one copy of a mutated SOD1 gene. The allele frequency is the calculation of mutated genes as a percentage of all copies of the gene. So as many as 37% of all the available genes in the breed are mutated copies.

Using the test for breeding choices

The genetic status of DM in dogs as measured by the current DM tests is one selection criteria among many others that must be considered by breeders. By doing the DM test and wisely interpreting the findings, genetic diversity and positive breed traits can be retained while reducing the incidence of the DM mutations found in the breed. The beauty of direct DNA tests is that no dog needs to be removed from an already limited gene pool.

Carrier and **at risk** dogs can be bred (and should be bred if they are good quality dogs) to dogs that are clear of both mutations in order to minimize the risk of producing **at risk** puppies that may become affected. In the event that there is a truly compelling reason to breed a carrier to a carrier, a breeder will want to research near relatives and pedigree information to see if both parents come from lines that show no signs of DM – and hope that the possible causative gene is not also present, or that the possible suppressor gene is present. An **at risk** to an **at risk** breeding will ONLY produce **at risk** puppies. Anyone choosing to do such a breeding would also want to have a great deal of pedigree information to use family history to try to minimize the possibility of producing puppies that may become affected.

The goal of breeders should be to gradually breed away from the mutations without creating genetic bottlenecks that may do significant harm to the future wellbeing of the breed as a whole. An example of sound genetic management advice can be found in the Austrian BMD Club's approach and recommendation which prohibits clear to clear matings. Breeding a DM clear to a DM clear can be done as an exception, but this club's breeding strategy was adopted to try to preserve overall diversity within the population, given the frequency of gene mutations for DM known to exist in dogs tested for DM. **[Note: A review of this process allowed the club to eliminate this requirement as of January 2017.]**

An approach involving a radical swift removal of DM carrier and **at risk** dogs given the high number of dogs with DM mutations will decrease genetic diversity which will not improve the future health of this health-challenged breed.

The **short term goal** needs to be avoidance of producing **at risk** puppies. A **longer term goal** is to gradually reduce the incidence of mutated genes as there may be beneficial traits linked to these mutated copies that we want to keep in the breed.

Below is a chart that can be used to summarize Genetic Status

SOD1-A	SOD1-B	Status
Clear	Clear	Clear
Carrier	Clear	Carrier
Clear	Carrier	Carrier
Carrier	Carrier	At Risk
At Risk	n/a*	At Risk
n/a*	At Risk	At Risk

* Because the SOD1 gene has only the A or the mutation and not both, a dog that is at risk for one will be clear of the other.

The following chart shows how to make use of those results in order to select a breeding partner to avoid producing **at risk** puppies

Breeding combinations to avoid producing at risk puppies

Status	Breed to:
Clear	anything
Carrier	Clear
At Risk	Clear

How many at risk dogs will become affected?

We still need to learn what percentage of dogs testing as **at risk** can be expected to become affected, and we can all help with that. Selecting a large enough sample of **at risk** dogs that then live long enough to be expected to start showing symptoms, and then doing necropsies on all of those dogs would be a method for determining what percentage of **at risk** dogs would be expected to become affected. Getting necropsies of **at risk** dogs to determine whether or not they have DM is key, and it's a difficult and expensive procedure. The Pearson Fund was created to help support this effort, and it will provide up to $500 toward the cost of the necropsy if needed. Contact the BMDCA Health Committee's Pearson Fund contact: Pat Long, at pat@bmdinfo.com.

As always, please add information to the Berner-Garde database. If you have an **at risk** dog, use the database to track the start and progression of symptoms (symptomatic), or the lack of symptoms as the dog ages symptom free (asymptomatic). This can help to track the age when symptoms first appear. Some have shown signs as early as six years – which would mean that this is not a disease of old age. Indicate whether the vets have ruled out other possible causes of rear-end paralysis and show that it is a presumptive case of DM. And do be sure to submit all the information about any necropsy results. It's never easy, but it's always greatly appreciated.

If you need help finding a facility that can do a necropsy to determine whether a dog was affected, or if you need help understanding the tests and their meaning, please contact the BMDCA Health Committee's subject matter expert on Degenerative Myelopathy: Fara Bushnell, at bernersandbirds@aol.com