

CMO Recessive or Dominant with Incomplete Penetrance

By Sil Sanders

Twenty years ago, scientists reported that Craniomandibular Osteopathy (CMO) was a simple recessive. Now they are saying it is Dominant with Incomplete Penetrance. What's going on?

I knew Dr. Padgett and his work 20+ years ago which used breeding studies to demonstrate that CMO was a simple recessive. Now, we have fantastic new technology and some excellent research which shows it to be Dominant with Incomplete Penetrance.

It turns out, if you study this, that the two modes are not that statistically different. At first glance, it looks like they differ a great deal in one practical aspect for breeders but even that is surmountable.

Dr. Padgett was right for his time and the technology he had available. He was aware that there was a statistical risk that CMO would turn out to be more complicated but he had enough data to “prove” it was simple recessive at the time. This is normal scientific progress.

The University of Bern scientists have much better tools and their paper is quite accessible to any breeder who cares to study it http://www.genetics.unibe.ch/unibe/vetmed/genetic/content/e2885/e3121/e186705/files186706/Interpretation_CMO_Gentest_e_eng.pdf. The paper shows that there is a single point mutation which causes the expression of a defective protein.

Warning – I will get a little technical here but I will try to keep it accessible:

Genetics is complex whether one thinks in terms of dominant/recessive or in terms of genes being blueprints or molds for proteins. Frankly, it is easier to avoid thinking in terms of dominant/recessive since that Mendelian model is too simple to describe things like incomplete penetrance.

Why Dominant with Incomplete Penetrance and Simple Recessive are similar is because of the way biology works. There are two copies of the gene, and a particular mutation might turn off that copy of the gene entirely or cause it to

produce a defective protein that may be a lot less useful than its normal form.

What I call a “normal gene” can be thought of as a mold to stamp out a protein which helps our body in some useful way. A “Flawed gene” (aka “mutated gene”) can be thought of as a flawed mold which stamps out a protein which doesn't do the work our body needs efficiently or if it is a big flaw, doesn't do anything at all.



- If your dog has two normal genes, both can produce the good protein and there will be plenty of good protein so everything is normal.
- If your dog has one normal gene, it can produce only half the normal amount of good protein. This might or might not be enough depending on lots of other genes and environmental conditions.
- If your dog has two flawed genes that produce weak protein, it may be good enough for everything to be normal but it may not.
- If your dog has two flawed genes that produce useless protein, your dog won't have any of this protein and so will show the abnormal disease.

What does that mean?

- If your dog has enough good protein he will not have CMO symptoms and he does not carry the gene for it. Yippee!
- If your dog has half the normal amount of good protein, there is a good chance he will not have CMO but he might as half-enough good protein might not be enough for him. Regardless of whether he has CMO symptoms, he carries the mutation.
- If both your dog's copies of the gene have the mutation, he gets a full dose of weak protein. There is a chance it works well enough for him that he does not have the CMO symptoms but most likely he will show them.

The genetic test tells us whether our dog has the point-mutation that causes CMO. Our eyes, ears, hands and X-Rays tell us whether our dog has the disease.

Given we now have a genetic test, how we breed is very similar whether the trait was simple recessive or Dominant with Incomplete Penetrance:

- Breed otherwise excellent dogs with two perfect genes to each other and none of the puppies will have CMO.
- Breed otherwise excellent dogs with one perfect gene and one mutated gene to dogs with two perfect genes, and test the puppies – preferring excellent dogs with two perfect genes to those with a single perfect gene for each generation BUT avoiding throwing out the baby with the bathwater. Expect a very small number of affected puppies – test for them, watch for them and treat them well.
- Breed otherwise excellent dogs with one perfect gene and one mutated gene to dogs with like gene pairs, and test the puppies – preferring excellent dogs with two perfect genes to those with a single perfect gene for each generation BUT avoiding throwing out the baby with the bathwater. Expect about 25% of these puppies will be affected – test for them, watch for them and treat them well.
- Breed exceptionally excellent dogs that have two mutated genes to excellent dogs with two perfect genes to get dogs with one good gene and one mutated gene and proceed as above in future generations.

CMO is a bad disease because it causes pain and suffering in the puppies but most cases can be treated – and the dogs lead happy lives as great companions to their owners. Westies also have other genetically caused or genetically influenced



diseases which are less treatable. So be cautious of focusing only on CMO.

The great thing is we can now test for it and responsible breeders can reduce the incidence in our breed so it becomes less and less prevalent.

I applaud the West Highland White Terrier Club of America (WHWTCA) and Westie Foundation of America (WFA) for their ongoing support of this research over the past 20+ years. It is great to have made progress on CMO and I look forward to more progress on this and other Westie afflictions.

About the author:

Sil and his wife Anne have been active for many years in Westie breeding (Rime Westies), Tracking, Obedience, Rally, Agility, Earthdog, Nose Work, and Barn Hunt. He has been an active member of the WHWTCA since 1976 and a strong supporter of WFA since its founding. When a litter produced a CMO puppy in 1989, they realized they needed to get involved in promoting healthy breeding of Westies. On any given day, you are likely to find him tracking with his two special Westies – 13 year old QT and 2 year old Twizzle.