



## Cerebellar Abiotrophy: A Review

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Cerebellar abiotrophy (CA), also referred to as cerebellar cortical abiotrophy (CCA), is a genetic neurological disorder in animals. It is known to affect the Arabian horse and is a recessive condition, meaning that both parents must carry and pass on the defective allele for an affected foal to be born. A DNA test is available to determine if a horse carries CA.

CA in horses is most commonly seen in Arabians and part-Arabians and has been recognized in virtually all bloodline groups. A few cases have been observed in the Miniature Horse, the Gotland Pony, and possibly the Oldenburg, but it is unknown if they are caused by the same genetic defect found in Arabians. CA also occurs in many breeds of dog. In addition to dogs and horses, there also have been cases in certain breeds of cats, cattle and sheep.



2-year old filly with Cerebellar Abiotrophy, exhibiting awkward gait

A horse with CA has a lack of balance, falls easily, often has an awkward wide-legged stance, a head tremor, startles easily, and cannot properly determine space and distance. While CA is not itself fatal, affected horses are frequently euthanized as foals because they are not coordinated enough to be ridden safely. They are also a danger to themselves because the condition predisposes them to accidents and injury.

CA cannot be cured, and the only way to prevent it is by selective breeding to avoid the possibility of producing an affected foal.

### Genetic Inheritance and Testing

CA in horses has a recessive mode of inheritance. This means that the CA allele has to be carried by both parents and passed on by both parents in order for an affected animal to be born. Horses that carry only one copy of the CA allele may pass it on to their offspring, but themselves are perfectly healthy—without clinical signs of the disorder. When both parents carry a single copy of the allele, there is a 25% probability that the ensuing foal will be affected with CA.

A DNA test developed at the University of California, Davis is available to horse owners and determines if a horse carries one or two copies of the CA allele. It can be performed using different tissues, but a hair root sample is preferred.

Test results are reported as "N", meaning that the mutation associated with CA is not present, or "CA" indicating the presence of the CA mutation. Because a horse inherits one copy of each allele from each parent, results are shown in pairs, representing the complete inheritance of the trait.

If two apparently healthy horses are bred to one another, the following statistical probabilities are possible.

- \*Two clear parents: N/N x N/N = Clear 100 %

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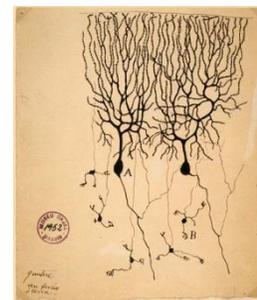
- \*One clear parent and one carrier parent:  $N/N \times N/CA =$  Clear 50 %, Carrier 50 %, Affected 0 %
- \*Two carrier parents  $N/CA \times N/CA =$  Clear 25 %, Carrier 50 %, Affected 25 %

If an affected horse (CA/CA) is used in breeding:

- \* $N/N \times CA/CA =$  Clear 0 %, Carrier 100 %, Affected 0 %
- \* $N/CA \times CA/CA =$  Clear 0 %, Carrier 50 %, Affected 50 %

## Inside the Brain

Cerebellar abiotrophy develops when certain neurons located in the cerebellum of the brain, known as Purkinje cells, begin to degenerate. These cells affect balance and coordination. They have a critical role to play in the brain. The Purkinje layer allows communication between the granular and molecular cortical layers in the cerebellum. Put simply, without Purkinje cells, an animal loses its sense of space and distance, making balance and coordination difficult.



Drawing of purkinje cells 1

Verifying the diagnosis in a laboratory setting is possible by examining the cerebellum post-mortem to determine if there has been a loss of Purkinje cells. While some other disorders exist that lead to neural degeneration in horses, the loss of Purkinje cells is unique to CA.

## Clinical Signs

Clinical signs of CA include ataxia or lack of balance, an awkward wide-legged stance, a type of head shaking known as an intention tremor, hyper-reactivity (the horse startles easily), lack of menace reflex or blink response, a stiff, excessively high-stepping gait in the forelimbs (known as hypermetric action), a stiff and abrupt quality of the gait in all limbs, a coarse or jerky head bob when in motion (or in very young animals, when attempting to nurse), apparent lack of awareness of where the feet are (sometimes trying to stand or walk with a foot knuckled over), poor depth perception, and a general inability to determine space and distance. Clinical signs of CA may become exacerbated when the horse is excited, and horses with CA are prone to falling down and running into things.

Most affected foals appear normal at birth, but the neurons in the cerebellum begin to degenerate, usually between 6 weeks and 4 months of age. Clinical signs are noticeable at an average age of four months, though there have been cases where the condition is first seen shortly after birth and other cases where the onset is gradual and thus clinical signs are first recognized in horses that are more than one year of age.

Not every affected horse will exhibit all clinical signs of CA, and the severity varies. While many cases are severe and clinical signs easily observed, there are also cases where the signs are very mild. Nonetheless, when taken as a group, the clinical signs of CA are fairly unique and not easily mimicked by other illnesses, though certain types of neurological injury and inflammation due to

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infection do need to be ruled out. Though distinguishable from other neurological conditions, many local veterinarians have never seen a case, or are not familiar with the clinical signs, thus CA has been confused with Wobbler's syndrome, Equine Protozoal Myeloencephalitis (EPM), and head injury.

However, the combination of clinical signs with lack of neurological damage to other areas of the brain or spine is unique enough that CA can be clearly distinguished from other neurological problems in a living animal. Genetic testing can determine if a horse is homozygous for CA, that is if it carries two copies of the CA allele, and thus is considered an affected animal. Histopathological examination of the cerebellum postmortem can further verify diagnosis.

Signs may worsen from the time of onset for six to 12 months, but if not severe enough to mandate euthanasia, they gradually stabilize over a period of one or two years. Most affected animals have normal intelligence and mildly affected animals can live out a normal lifespan. However, affected horses are quite accident-prone. They may experience difficulty stepping up and over objects, run into fences, fall easily, and even if allowed to mature to full growth, are generally considered unsafe to ride. Thus, many horses that develop CA are euthanized for humane reasons. There is anecdotal evidence that affected animals partially compensate for the condition by cognitively learning alternative methods for moving or to determine distance. Thus, they appear to improve because they become less accident-prone and may learn to control levels of activity when anxious.

## Research History

In November 2010, it was announced that the probable causative mutation for CA was mapped to a microsatellite marker on ECA2 (horse chromosome 2) in a location of two overlapping genes. This led to a more fully developed DNA test available to horse owners that improved upon the previous indirect marker test that was developed in December 2007. Retesting selected results showed that the previous test was 97% accurate with no false negatives relative to the new test. The research leading to this discovery was performed at the Veterinary Genetics Laboratory at the University of California, Davis by Leah Brault and Dr. Cecilia Penedo. As of 2010 over 6,650 animals had been tested. 79.67 percent of all animals tested were found to be "clear," 19.26% were carriers and 1.07% were determined to be affected.

The earliest studies of CA in Arabians, then called Cerebellar Hypoplasia, were published in 1966. Cerebellar abiotrophy in horses was originally thought to be a form of cerebellar hypoplasia, a condition where the loss of Purkinje cells occurs before the animal is born, and CA cases were described as such in older research literature. However, it was determined that the decline of Purkinje cells in horses usually began after the animal was born, not in utero.

Major research efforts took place at the Veterinary Genetics Laboratory at the University of California-Davis School of Veterinary Medicine and the Institute of Genetics at the University of Bern, Switzerland. Researchers working on this problem include Dr. Cecilia Penedo, PhD and Leah Brault, Veterinary Genetics Laboratory, UC Davis; Prof. Dr. Tosso Leeb, Molecular Geneticist, Institute of Genetics, and PD Dr. med. vet. Vinzenz Gerber, PhD, DACVIM, DECEIM, FVH, Head of Equine Internal Medicine, Vetsuisse-Fakulty, University of Bern. The late Dr. Ann T. Bowling also made

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significant contributions to the genetics research on CA at UC Davis, performing breeding experiments, including an F1 test-cross that supported an autosomal mode of inheritance.

## What Can Be Done?

Owners interested in having horses screened for CA can request the test directly from the Veterinary Genetics Laboratory (VGL) at UC Davis through the following website:

<http://www.vgl.ucdavis.edu/services/horse.php>.

Selective breeding to avoid two carriers from being bred to one another is the only way to completely avoid producing an affected foal. Owners of an affected foal need to be aware that because such a horse is homozygous for CA, that is, it carries two alleles for the condition, all offspring of such a horse will be carriers, regardless of the carrier status of the other parent.

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## CREDITS

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## SOURCES

### Treatises:

\*de Lahunta, A., Saunders, *et al.* *Veterinary Neuroanatomy and Clinical Neurology*, 2nd ed., 1983

\*Summers, B.A., Cummings, J.F., de Lahunta, A. *Veterinary Neuropathology*. Mosby, St. Louis, MO, 1995.

### Periodicals and online materials:

\*Adams, Ragan (M.A., D.V.M.); Mayhew, Ian G. (B.V.Sc., Ph.D.) (April 1985). "Neurologic Diseases". *Veterinary Clinics of North America: Equine Practice* **1** (1): 209–234.

\*AHA Equine Stress, Research and Education Committee (August/September 2007). "[Caution and Knowledge](#)". *Modern Arabian Horse*: 100–105.

\*Baird JD, Mackenzie CD. (January 1974) "Cerebellar hypoplasia and degeneration in part-Arab horses." *Aust Vet J.*; 50(1):25-28. <http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?>

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[cmd=Retrieve&db=PubMed&list\\_uids=4819469&dopt=Citation](#)

\*Beatty, Margaret T., Leipold, H.W., Cash, W., et al. (1985) "Cerebellar Disease in Arabian Horses," *Proceedings of the 21st annual convention of the American Association of Equine Practitioners*, 241-255.

\*Björck, G., Everz, K.E., Hansen, H.-J. and Henricson, B., (1973). "Congenital cerebellar ataxia in the Gotland pony breed." *Zbl. Vet. Med.* 20:341-354. [http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=4199630&dopt=Citation](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=4199630&dopt=Citation)

\*Blanco A, et. al. (August 2006). "Purkinje cell apoptosis in arabian horses with cerebellar abiotrophy." *Journal of Veterinary Medicine Series A*; 53(6):286-287. <http://www.blackwellsynergy.com/doi/abs/10.1111/j.1439-0442.2006.00836.x>

\*Brault, L.S., C.A. Cooper, T.R. Famula, J.D. Murray M.C.T. Penedo. (2011) "Mapping of equine cerebellar abiotrophy to ECA2 and identification of a potential causative mutation affecting expression of *MUTYH*" *Genomics*, doi:10.1016/j.ygeno.2010.11.006.

\*Brault, L.S., T.R. Famula, M.C.T. Penedo. (2010) "Inheritance of equine cerebellar abiotrophy in Arabian horses." *American Journal of Veterinary Research* (accepted, publication pending).

\*"Changing Times: Cerebellar Abiotrophy". Column. *J. Equine Vet. Sci.* **25** (10): 452. October 2005. [doi:10.1016/j.jevs.2005.09.010](https://doi.org/10.1016/j.jevs.2005.09.010).

\*"Cerebellar Abiotrophy," Fact sheet, UC Davis Veterinary Genetics Laboratory. Accessed online April 28, 2010 at <http://www.vgl.ucdavis.edu/genomic/cerebellar/>

\*DeBowes R.M., et. al. (August 1987) "Cerebellar abiotrophy." *Vet Clin North Am Equine Pract.*; 3(2):345-352. [http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3497695&dopt=Citation](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3497695&dopt=Citation)

\*de Lahunta, A. (January 1990) "Abiotrophy in domestic animals: a review." *Can J Vet Res.*; 54(1): 65-76. <http://www.pubmedcentral.gov/articlerender.fcgi?artid=1255608>

\*Fox, J., et. al. (May 2000) "Cerebello-Olivary and Lateral (Accessory) Cuneate Degeneration in a Juvenile American Miniature Horse." *Vet Pathol.*; 37(3):271-274. <http://www.vetpathology.org/cgi/content/full/37/3/271>

\*Gerber H, Gaillard C, Fatzer R, Marti E, Pfistner B, Sustronck B, Ueltschi G, Meier HP, Herholz C, Straub R, Geissbuhler U, Gerber V. (1995) "Cerebellare Abiotrophie bei Vollblutaraber-Fohlen" ("Cerebellar Abiotrophy in Pure-bred Arabians") (German). *Pferdeheilkunde*;11:423-443 <http://direct.bl.uk/bld/PlaceOrder.do?UIN=001143128&ETOC=RN&from=searchengine>

\*Goodwin-Campiglio, Lisa. "Cerebellar Abiotrophy." F.O.A.L., accessed Goodwin-Campiglio, Lisa. "Cerebellar Abiotrophy. *F.O.A.L. website*. Accessed April 28, 2010 at <http://www.foal.org/Cerebellar-Abiotrophy---CA-.html>

\* Goodwin-Campiglio, Lisa. "Genetic Disorders in Arabian Horses: Current Research Projects. *World Arabian Horse Association*. Accessed October 23, 2007 at <http://www.waho.org/History/GeneticResearch.html>

\*Hahn, Caroline. (2006) "The wobbly horse: differential diagnoses" *In Practice* (UK), 28:8-13 <http://inpractice.bvapublications.com>

\*Johnson, Robert S. "Test Allows Arabian Breeders to Scan for Inherited Neurologic Disorder. *The Horse*, online edition, September 23, 2008, Article #12746. Accessed April 28, 2010 at <http://www.thehorse.com/ViewArticle.aspx?ID=12746&nID=17&src=RA>

\*MacKay, Robert. (August 2005) "Neurologic Disorders of Neonatal Foals." excerpt published in

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*Vet. Clin. North Am. Equine Pract.* 21(2): 387-406, vii

\*Palmer, A.C., Blakemore, W.F., Cook, W.R., Platt, H. and Whitwell, K.E. (1973) "Cerebellar hypoplasia and degeneration in the young Arab horse: clinical and neuropathological features."

*Veterinary Record* 93:62-66 [http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=4748678&dopt=Citation)

[cmd=Retrieve&db=PubMed&list\\_uids=4748678&dopt=Citation](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=4748678&dopt=Citation)

\*Penedo, M. Cecilia T. and Leah Brault. (2006) "Progress Toward Identifying the Gene Responsible for Equine Cerebellar Abiotrophy (CA)." *Genetics, Research Review*, Center for Equine Health, University of California, Davis. <http://www.vetmed.ucdavis.edu/ceh/pubs-RR06-Genetics-sec.pdf>

\*Reich, Cindy. (March 2007) "Genetic Diseases: Breed Responsibly", *Arabian Horse World*: Volume 47 no. 6, pp. 277-279.

\*Reich, Cindy (January 2009). "Cerebellar Abiotrophy: Carrier Status Announced". *Arabian Horse World*: 438-439.

\*Sponseller, Brett A. (1994) *A Pedigree Analysis of Cerebellar Cortical Abiotrophy in the Arabian Horse*. (Fourth-year seminar paper). Ithaca, NY: College of Veterinary Medicine, Cornell University. <http://dspace.library.cornell.edu/handle/1813/3013>

\*Sponseller, Max. (1967) "Equine cerebellar hypoplasia and degeneration." *Proceedings of the 13th annual convention of the American Association of Equine Practitioners*; 123-126

\*Waelchli RO, Ehrensperger F (November 1988). "Two related cases of cerebellar abnormality in equine fetuses associated with hydrops of fetal membranes ", *Veterinary College, University of Zurich, Switzerland. The Veterinary Record*, Vol 123, Issue 20, 513-514.

<http://veterinaryrecord.bvapublications.com/cgi/content/abstract/123/20/513>

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