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MRI assisted morphometric and anatomic-histological examination of the Chiari malformation in the “Cavalier King Charles Spaniel”, a brachycephalic breed of dog

This thesis shows the use of MRI imaging in the diagnosis and morphometric evaluation of anatomical changes of the caudal fossa in Cavalier King Charles Spaniels (CKCS) possessing from Chiari malformation. In Chiari malformation the caudal cerebellar vermis typically herniates through the foramen magnum and is associated with a widening of the cord canal of the cervical spinal cord (syringohydromyelia). This distension of the central canal is also referred to as a syrinx.

Measurements of the caudal fossa of the CKCS both with and without syringes were compared to each other as well as to MRI images of those of other breed of dogs with a similar bodyweight to the Cavalier. Additionally, CT- and histological examinations of a Cavalier bitch validate the results of the other Cavaliers.

In total, MRI images of 77 CKCS and 32 other breed of dogs were obtained and evaluated morphometrically and graphically. Distances between certain bony landmarks in the caudal fossa showed some correlation to the occipital volume. Both, the ventrodorsal and the rostrocaudal dimension of the cerebellum were measured as well as the length of tissue herniated through the foramen magnum. Furthermore, the volume of the resulting intramedullary syringes could be obtained.

Following results could be obtained from this thesis:

Midlinesagittal MRI images are suitable for the morphometric examination of the cerebellum and cervical spinal cord.

There were no significant age- or gender related differences concerning syrinx formation. However, there was a large number of CKCS of the “Blenheim” colour in the syrinx forming group.

The CKCS cerebellum seemed generally greater ventrodorsally and more caudally elongated than that of the control group. The length of herniated cerebellar tissue and the quotient derived from the caudal cerebellar rostrocaudal dimension and the cerebellar ventrodorsal dimension both seem to have an effect on syrinx formation statistically. The volume of the syrinx, however, does not seem to be influenced by morphometric cerebellar changes.

There are only small discrepancies in the measurements of the caudal fossa of the CKCS group and the control group. However, an exceptionally large number of dogs with a large foramen magnum and a short squama occipitalis are CKCS; this does not, however, seem to influence syrinx formation.

The pathogenesis of Chiari malformation still seems to be a poorly understood process. However, the shape of the cerebellum, the dorsally enlarged foramen magnum with an absent dura mater at this point and the convex and thin squama occipitalis allow the formation of a high cerebrospinal fluid (CSF) pressure gradient between the ventricles and the cerebellomedullary cistern during embryonic development.

Syrinx formation in the cervical spinal cord seems influenced by a cardiac systole-dependant piston-like effect created by the herniated cerebellar tissue, in which spinal fluid is forced into the central canal dependent on blood pressure. However, it is likely that a high blood pressure will cause transparenchymal osmosis of CSF. Indirectly, the seal of a midline entry to the area proves the existence of a functional aperture mediana ventriculi quarti (Foramen magendie) in the CKCS.

As a result of this thesis it was possible to obtain some parameters through MRI scanning which may guide the choice of breeding stock that are less likely to perpetuate Chiari malformation. This should lead to gradual change in the cerebellar rostrocaudal dimension and the length of herniated tissue.