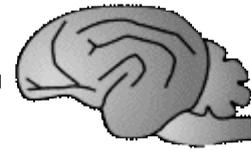


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CANINE CHIARI-LIKE MALFORMATION AND SYRINGOMYELIA

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Chiari-like malformation (CM) is a condition characterised by a mismatch between the caudal fossa (skull) volume and its contents, the cerebellum and brainstem. The neural structures are displaced into the foramen magnum obstructing cerebrospinal fluid (CSF) movement. A consequence of this is syringomyelia (SM) where fluid filled cavities develop within the spinal cord (Fig 1). The primary clinical sign of CM/SM is pain, either due to obstruction of the CSF pulse pressure and/or a neuropathic pain syndrome due to damage to the spinal cord dorsal horn. This disease has also been referred to as occipital hypoplasia (Rusbridge et al 2006) and caudal occipital malformation syndrome (COMS) (Dewey et al 2005). CM/SM is sometimes erroneously confused with Arnold Chiari malformation (cerebellar and medulla herniation associated with myelomeningocele) and occipital dysplasia (incomplete ossification of the supraoccipital bone).

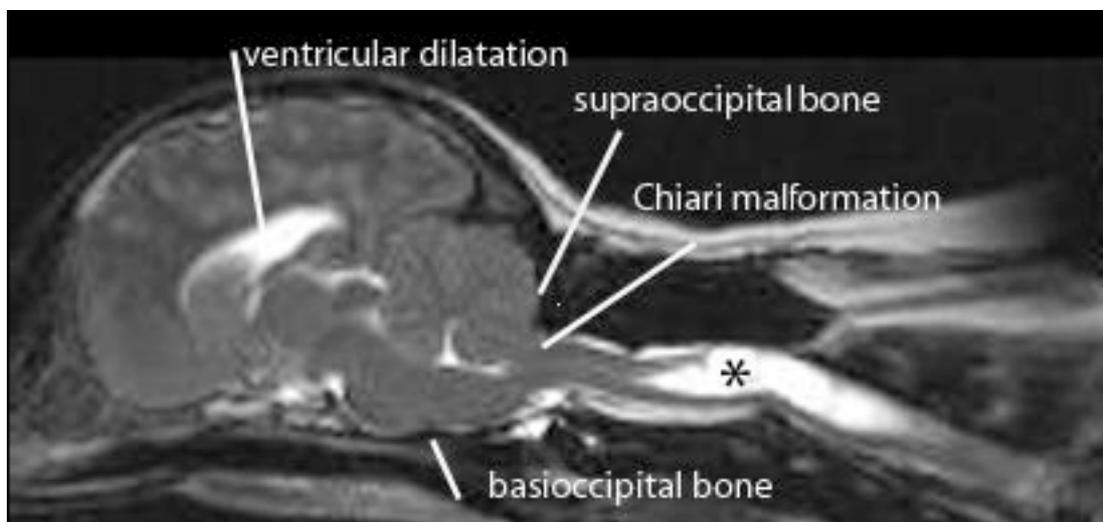


FIGURE 1: Midsagittal T2 weighted MRI of the brain and upper cervical spinal cord from 3 year old female CKCS with syringomyelia (asterisks) that first developed signs of pain at 1.7years old. Clinical signs included shoulder scratching at exercise and when excited. She would not tolerate her right ear to shoulder area to be touched or groomed. She frequently screamed and her owners were not able to exercise without her becoming distressed. She also had mild pelvic limb weakness. She was managed with a foramen magnum decompression and despite persistence of the syrinx, made a satisfactory post operative that was maintained for 1.8years. Following this deterioration she was managed medically for a further 3.8 years and is currently 7 years old.

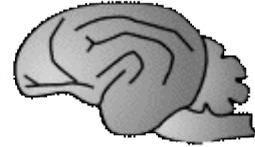
PATHOGENESIS

The pathogenesis of canine CM/SM is not fully understood. An important contributory factor is thought to be that the brain is too big for the skull and early studies suggest that there is an inappropriately short skull base (basioccipital bone (Fig 1). Cavalier King Charles spaniels (CKCS) with clinical signs related to syringomyelia are more likely to have a smaller ratio of cauda fossa (i.e. back of skull) volume to total brain volume compared to unaffected CKCS (Cerde-Gonzalez et al 2006). However it is likely there are other unidentified anatomical or environmental factors. Studies comparing skull dimensions did not demonstrate a significant difference between the size of the back of the skull in CKCS with and without syringomyelia (Curruthers et al 2006, Cerde-Gonzalez et al, 2006).

The precise pathogenetic mechanism of development of syringomyelia is much debated (reviewed by Rusbridge et al, 2006; Greiz, 2006). The most popular theory is that obstruction of CSF flow results in relative increase in spinal cord pressure and decrease in pressure in the CSF space around the spinal cord, the consequence of which is repeated mechanical distention of the spinal cord. This in turn results in

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dilatation of the central canal and accumulation of tissue fluid which eventually coalesces into cavities.

INCIDENCE

The CKCS is overwhelmingly overrepresented for cases of CM/SM. There is no colour or sex predisposition. As shortened skull is a risk factor, any breed with a degree of brachycephalism and/or miniaturization could potentially be predisposed to CM/SM. To date the condition has been also reported in King Charles spaniels, Brussels griffons, Yorkshire terriers, Maltese terriers, Chihuahuas, Miniature dachshunds, Miniature/toy poodles, Bichon Frise, Pugs, Shih Tzus, Pomeranians, Staffordshire bull terriers, a Boston terrier, French bulldogs a Pekingese, a miniature Pinscher and a couple of cats. Recent studies suggest 35% of SM-affected dogs have clinical signs of the condition. The youngest reported dogs with SM have been 12 weeks old. Dogs may be presented at any age although the majority of dogs (approximately 45%) will develop first signs of the disease within the first year of life and approximately 40 % of cases have first signs between 1 and 4 years old. As many as 15% develop signs as mature dogs with the oldest reported case first developing signs of disease aged 6.8 years. Due to the vague nature of signs in some cases and lack of awareness about the disease there is often a considerable time period (mean 1.6 years) between the onset of signs and confirmation of a diagnosis.

CLINICAL SIGNS

The most important and consistent clinical sign of CM/SM is pain however this may be difficult to localise. Owners may describe postural pain; for example, affected dogs may suddenly scream and/or lie with the head on the ground between the paws after jumping up or during excitement. It is also common to sleep with the head in unusual positions, for example elevated. Discomfort often appears worse in the evening and early morning or when excited and can be associated with defecation or may vary with weather conditions. Pain is positively correlated with syrinx width and symmetry (Fig 2); i.e. dogs with a wider asymmetrical syrinx are more likely to experience discomfort, and dogs with a narrow syrinx may be asymptomatic, especially if the syrinx is symmetrical. Dogs with a wide syrinx may also scratch, typically on one side only, while the dog is walking and often without making skin contact, such behaviour is often referred to as an “air guitar” or “phantom” scratching. Dogs with a wide syrinx are also more likely to have scoliosis. In many cases the scoliosis slowly resolves despite persistence of the syrinx.

SM may result in other neurological deficits such as thoracic limb weakness and muscle atrophy (due to ventral horn cell damage) and pelvic limb ataxia and weakness (due to white matter damage or involvement of the lumbar spinal cord by the syrinx). Seizures, facial nerve paralysis and deafness may also be seen; however, no direct relationship has been proven and this association may be circumstantial.

CM alone appears to cause facial pain in some dogs with owners describing ear and facial rubbing/scratching. It has been proposed that CM and compression of the brain stem can result a pain syndrome (Thimineur et al, 2002). In this circumstance it can be difficult to be certain that the CM, as apposed to ear, oral or skin disease, is the cause of the distress especially as CM is a common incidental finding in the CKCS breed.

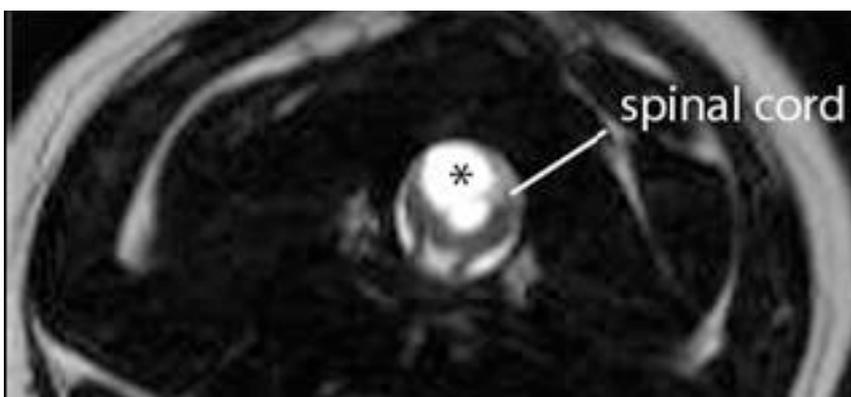


FIGURE 2: T2 weighted transverse image through a wide syrinx (asterisks) demonstrating the

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asymmetrical involvement of the right spinal cord dorsal horn.

CLINICAL COURSE

Progression of disease is variable. Some dogs remain stable or deteriorate minimally over years. Other affected dogs can be severely disabled by pain and neurological deficits within 6 months of the first observed signs.

DIAGNOSIS

Magnetic resonance imaging (MRI) is essential for diagnosis and determining the cause of SM (Fig 1). In the instance of CM/SM the cerebellum and medulla extend into or through the foramen magnum which is occluded with little or no CSF around the neural structures. The size of the cerebellar herniation is not correlated with severity. There is typically ventricular dilatation. SM is indicated by fluid-containing cavities within the spinal cord. The upper cervical and upper thoracic segments are typically most severely affected. Maximum syrinx width is the strongest predictor of pain, scratching behaviour and scoliosis; 95% of CKCS with a maximum syrinx width of 0.64cm or more will have associated clinical signs.

CT and radiographs have limited value. In severe cases cervical images may suggest widening of the vertebral canal especially in the C2 region and/or scoliosis. Flexed and extended radiographs of neck can be used to rule out vertebral abnormalities such as atlantoaxial subluxation and for an indication of the likelihood of intervertebral disc disease.

Ultrasonography through the cisterna magnum may confirm cerebellar vermis herniation however as CM is so common in the CKCS this information has limited value. Likewise a syrinx may be identified if within the cranial/cervical segment; however, failure to detect a syrinx does not eliminate the possibility of one more caudally. CM/SM does not appear to increase risk of anaesthesia.

DIFFERENTIAL DIAGNOSIS

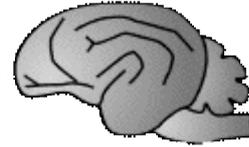
The most important differential diagnoses are other causes of pain and spinal cord dysfunction such as intervertebral disc disease; CNS inflammatory diseases such as granulomatous meningoencephalomyelitis; vertebral abnormalities such as atlantoaxial subluxation; neoplasia; and discospondylitis. When scratching or facial/ear rubbing is the predominant clinical sign, ear and skin disease should be ruled out. The scratching behaviour for SM is classically to one distinct area. It is a common incidental finding for CKCS to have a mucoid material in one or both tympanic bullae and in the majority of cases this is not associated with clinical signs. Some cases with scoliosis appear to have a head tilt which could be confused with vestibular dysfunction. If in doubt cervical radiographs can confirm scoliosis.

TREATMENT

The main treatment objective is pain relief. The most common surgical management is cranial/cervical decompression (also described as foramen magnum or suboccipital decompression) establishing a CSF pathway via the removal of part of the supraoccipital bone and dorsal arch of C1. This may be combined with a durotomy (incision of the dura with/without incision of subarachnoid meninges) with or without patching with a suitable graft material. Cranial/cervical decompression surgery is successful in reducing pain and improving neurological deficits in approximately 80% of cases and approximately 45% of cases may still have a satisfactory quality of life 2 years postoperatively (Rusbridge 2007). However surgery may not adequately address the factors leading to SM and the syrinx appears persistent in many cases (Rusbridge 2007). The clinical improvement is probably attributable to improvement in CSF flow through the foramen magnum. In some cases scarring and fibrous tissue adhesions over the foramen magnum seem to result in re-obstruction and 25% to as many as 50% of cases can eventually deteriorate (Dewey et al 2005, Rusbridge 2007). This can be as early as 2 months postoperatively. Recently, a cranioplasty procedure used in human cranial/cervical decompression surgery has been adapted for use in dogs. The procedure entails placement of a plate constructed of titanium mesh and polymethylmethacrylate (PMMA) on pre-placed titanium screws bordering the occipital bone defect (Dewey et al 2006). An alternative method of managing SM is direct shunting of the cavity. In humans this is not a preferred technique as long term outcome is poor due to shunt obstruction and/or spinal cord tethering. There has been a single report of syringo-subarachnoid

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shunting in a dog using an equine ocular lavage tube. However post-operative MRI revealed that SM was still prominent although there was a clinical improvement in the dog (Skerritt and Hughes 1998).

Due to the persistence of SM and/or spinal cord dorsal horn damage it is likely that the post-operative patient will also require continuing medical management for pain relief and in some patients medical management alone is chosen because of financial reasons or owner preference. There are three main drugs used for treatment of CM/SM: drugs that reduce CSF production; analgesics; and corticosteroids (Fig 3). If the dog's history suggests postural pain or discomfort relating to obstruction of CSF flow then a trial of a drug which reducing CSF pressure, e.g. furosemide, cimetidine or omeprazole, is appropriate. This can also be very useful if it is difficult to determine if the cause of discomfort is CM versus, for example, ear disease. CSF pressure reducing drugs may be sufficient to control signs in some dogs, but additional analgesics are likely to be necessary for an individual with a wide syrinx. In this circumstance we suggest that non steroidal anti-inflammatory drugs are the medication of first choice partly because there are several licensed products. However, for dogs with signs of neuropathic pain, i.e. allodynia and scratching behaviour (suspected dysesthesia); a drug which is active in the spinal cord dorsal horn is more likely to be effective. Because gabapentin has established use in veterinary medicine we suggest that this is the drug of first choice but amitriptyline or pregabalin may also be suitable. Corticosteroids are an option if pain persists or where available finances prohibit the use of other drugs. Because the mechanisms of development of neuropathic pain are multifactorial, appropriate polypharmacy is likely to be more effective than treatment with single agents. Anecdotally, acupuncture and ultrasonic treatments have been reported to be useful adjunctive therapy in some cases. The dog's activity need not to be restricted but owner should understand that dog may avoid some activities and grooming may not be tolerated. Simple actions, for example raising the food bowl and removing neck collars, can also help.

PROGNOSIS

Prognosis for CM/SM managed medically is guarded especially for dogs with a wide syrinx and/or with first clinical signs before 4 years of age. Study of a small case series (14 CKCS) managed conservatively for neuropathic pain suggested that 36% were eventually euthanatized as a consequence of uncontrolled pain. However 43% of the group survived to be greater than 9 years of age (average life expectancy for a CKCS is 10.7 years). Most dogs retain the ability to walk although some may be significantly tetraparetic and ataxic.

BREEDING RECOMMENDATIONS

Current breeding recommendations for CKCS concentrate on removal of dogs with early onset SM (i.e. within the first 2.5 years of life) from the breeding pool (for precise recommendations and grading system see <http://www.sm.cavalierstalk.com>).

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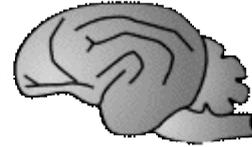
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