# **Caudal Occipital Malformation Syndrome and Syringomyelia in a Cavalier King Charles Spaniel**

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## ABSTRACT

A 17-month old female spayed Cavalier King Charles Spaniel presented for suspected caudal occipital malformation syndrome. She had, over the past few months, started showing neurological signs consistent with such a diagnosis and because of the high prevalence in the breed, the owners requested a thorough work-up.

On presentation, the dog had exhibited pain along her cervical spine, a left head tilt, and started scratching at the back of her head incessantly. She was initially managed with pain medication by the referring veterinarian but her clinical signs waxed and waned prompting her arrival to Cornell University's Hospital for Animals Neurology Service. Radiography, MRI, and CT scans were all consistent with syringomyelia secondary to caudal occipital malformation syndrome. Because of the better long term prognosis with surgical intervention[1] the patient underwent foramen magnum decompression with cranioplasty and was managed post-operatively with appropriate analgesia (gabapentin). Although the patient experienced some anticipated post-operative complications, each subsequent follow-up examination revealed improvement to her clinical signs.

## SIGNALMENT

Bellis, a 17 month old female spayed Cavalier King Charles Spaniel, presented to Cornell University's Hospital for Animals Neurology Service in January of 2008 for evaluation of neurologic deficits. Her owners had noticed that she seemed to be quite painful along her head and neck and had developed a slight left head tilt. Bellis would also enter "scratching fits" after waking up from a nap or defecation which would last for approximately fifteen minutes. These clinical signs began when she was nine months old but disappeared briefly after a course of pain medication was prescribed by the referring veterinarian. Unfortunately, the medication did not subside all clinical signs and they soon became refractory, prompting her referral to CUHA's Neurology Service. Being astute to the breeds' predilection to the neuroanatomical defect, caudal occipital malformation syndrome (COMS), Bellis' owners' concerns were heightened and they decided to pursue further diagnostics and treatment.

On presentation, Bellis was quiet, alert, and responsive. She was in excellent body condition with a body condition score of 4.5/9 (5.42kg). Her vital parameters were well within normal limits and thoracic auscultation revealed no abnormalities. On neurological examination, Bellis had lateral strabismus in her right eye, multifocal pain along her cervical spine, conscious propioceptive deficits in both hind limbs, a left head tilt, and she began scratching at the back of her head during the examination.

Given her clinical signs, neuroanatomical localization of the lesion was caudal brainstem and a C1-C5 deficit. Main differential diagnoses include; intervertebral disc disease (IVDD), caudal occipital malformation syndrome (COMS), hydrocephalus, atlantoaxial (A-A) luxation, syringomyelia (SM), vestibular disease, otitis media/interna, and granulomatous menginoencephalomyelitis (GME). As a breed, the Cavalier King Charles Spaniel, commonly is affected by IVDD, syringomyelia, hydrocephalus, A-A luxation, and COMS which helped narrow down the differential diagnoses and allow for the appropriate starting point for diagnostic testing to accurately pursue the cause of Bellis' clinical signs.

## DIAGNOSTICS

Blood was drawn for a complete blood count and chemistry profile, which was unremarkable aside from her marked thrombocytopenia (74 thou/uL). While this is an alarming finding in most breeds, recent studies have shown that there is a high prevalence of idiopathic macrothrombocytopenia within the Cavalier King Charles Spaniel breed and appears to have no direct effect to clotting times.[2] Bellis was then placed under general anesthesia for the appropriate imaging studies required to make a definitive diagnosis; cervical radiographs, MRI, and CT scan.

Lateral radiographs were taken in both a neutral and flexed position of the head and neck to help rule out A-A luxation and IVDD. The space between C1 and C2 was normal in both the neutral and flexed position, thus ruling out A-A luxation as a potential cause for Bellis' clinical signs. Upon closer evaluation, all intervertebral spaces were uniform with no evidence of compression within C1-C5 region, suggesting the unlikelihood of IVDD.

MRI of the head and neck, in both sagittal and transverse planes, revealed a large, linear, non-contrast enhancing lesion that was hyperintense to the spinal cord on T2 and hypointense on T1 extending from C2-C7 in the dorsal spinal cord. Within the lesion, from C2-C4, a dorsal-to-ventrally directed septation was present with its coalescence at the level of C5. In the head, it was noted that the ventricular system was large and in the left tympanic cavity a moderate volume of material was seen that was hyperintense to the brain on T1 and T2. The dorsal subarachnoid space at the level of the foramen magnum was also absent in the images. In summary, the information obtained from MRI gave conclusive evidence of syringomyelia (probably secondary to COMS), left otitis media (incidental finding), mild ventriculomegaly, cerebellar herniation, and a space-occupying defect in the medulla. Both cerebellar herniation and the compression in Bellis' medulla are classic MRI findings in caudal occipital malformation syndrome.[3]

Evaluation of CT images revealed the cranial aspect of the dorsal arch of the atlas was at the level of, or slightly rostral to, the foramen magnum and gave confirmation to the fluid accumulation in the left tympanic cavity, seen as a small volume of fluid-dense material.

Based on Bellis' breed, clinical signs, and imaging studies a definitive diagnosis of syringomyelia (SM) secondary to caudal occipital malformation syndrome (COMS) was made.

**THE ANATOMY OF COMS AND SYRINGOMYELIA**

COMS can be defined as the malformation of the occipital region that leads to a small caudal fossa with cerebellar herniation and compression of the brain stem. It is thought that the bony compression at the cervicomedullary junction,[4] in conjunction with turbulent cerebral spinal fluid (CSF) flow and pressure changes in the region,[5] results in the hypertrophy of the underlying meninges, as well as dural fibrosis. The focal meningeal hypertrophy at the level of the foramen magnum, is believed to be responsible for the progressive constriction at the cervicomedullary junction, in turn leading to the increased CSF pressure of the intracranial and spinal compartments.[4]

In time, the build up of CSF pressure results in the development of fluid-containing cavities within the parenchyma of the spinal cord, called syringomyelia. Fluid collected from these cavities, commonly found within the dorsal funiculus, has a different chemistry when compared to collected CSF from the same patient. This accumulation of fluid, nonetheless, causes anatomical, neurochemical, and inflammatory changes all along the affected cord.[6]

Anatomically, as fluid accumulates within the dorsal funiculus, the damage starts centrally and dissects to the outer spinal cord resulting in death or dysfunction of specific cell types in the dorsal horn, a region which may be implicit in the development of syringomyelic pain.[7] This area plays a pivotal role in pain perception as it receives sensory information from the periphery (pain, temperature, and touch) and is subject to considerable local and descending modulation. Nociceptive information (mechanical, thermal, and chemical) is transmitted by small non-myelinated C fibers which terminate predominantly in laminae I and II [of the dorsal horn] with some fibers penetrating to deeper layers.[8,9] The C fibers release excitatory neurotransmitters, in particular substance P and glutamate, and produce slow excitatory postsynaptic potentials that facilitate the ascending pain pathways. It is entirely plausible that the damage caused by the syringomyelia may cause an imbalance between the various processing pathways, resulting in extreme neuropathic pain.[6]

Neurochemical changes are thus seen due to the altered expression of neurotransmitters (or changed expression of receptors) inevitably from the anatomical changes described above. This leads to a substantial increase in substance P protein caudal to the syrinx which would likely alter modulation and perception of pain. These alterations, may in turn, result in changes in concentrations of other neurotransmitters, such as GABA, resulting in the disinhibition of pain pathways; causing the exaggerated response to pain.[6]

Finally, the inflammatory component of syringomyelia perhaps leads to persistent pain mediated through glial cell production of cytokines (interleukin-1) causing an increase in substance P and hence altered expression of nociceptive peptides.[10]

## TREATMENT: MEDICINAL

Since pain is the predominant feature of the disease (COMS/SM) and it is reported in approximately 35% of affected dogs,[6] it's only practical that the medicinal route targets pain control. Dogs exhibit behavior suggestive of neuropathic pain which is described in the literature as abnormal somatosensory processing in the peripheral or central nervous system potentially including spontaneous pain, allodynia, or hyperpathia. Gabapentin is the drug of choice for targeting neuropathic pain control because it is thought to prevent the release of glutamate in the dorsal horn via interaction with the α2δ subunit of the voltage-gated calcium channels responsible for the pain pathway as described above.[6] Tramadol (an opioid mu agonist) and prednisone (anti-inflammatory steroid) are also acceptable to use in conjunction to gabapentin for further control. It is important to note that, medical treatment may work well initially but most dogs do eventually become refractory to treatment eventually requiring surgery.[1]

## TREATMENT: SURGICAL

Foramen magnum decompression with cranioplasty is the current surgical treatment of choice for COMS in young, rapidly progressing dogs that are not responding to medications.[11,12] Given the extent of Bellis' cerebellar herniation and pressure on her medulla it was decided to pursue the most aggressive form of treatment with the objective to halt the progression of the disease process. The ultimate goal of the surgery is to release the compression on the cerebellum and to allow normal laminar CSF flow; with hopes of resolving the syringomyelia, cerebellar herniation, and medullary compression caused by the occipital bone malformation.

On 2/6/2008, Bellis was admitted to the hospital and was prepared for surgery. She was placed in sternal recumbency, with the neck ventroflexed and a dorsal midline incision was made extending from approximately 1 cm rostral to the external occipital protuberance cranially to the middle of the second cervical vertebrae caudally exposing the superficial dorsal cervical musculature which was then subsequently separated at the median raphe, exposing the underlying biventer cervicis muscles. The paired biventer cervicis muscles were separated on the midline, exposing the rectus capitis dorsalis muscles. The caudal aspects of the rectus capitis dorsalis muscles were removed from the cranial half of the second cervical vertebra with a combination of sharp dissection and periosteal elevation, and the muscle bellies were split on the midline. The cranial aspects of the rectus capitis dorsalis muscles were then sharply incised from the nuchal crest, exposing the caudal portion of the occiput and the arch of the atlas.

A high-speed air drill was used to remove a portion of the occiput, exposing the vermis of the cerebellum. The then exposed menginges were incised longitudinally with a scalpel blade to further alleviate pressure at the cervicomedullary junction. A complete laminectomy was performed on C1 and half of the cranial aspect of the spinous process of C2 was removed to resolve the medullary and spinal cord compression.[11]

Cranioplasty was then performed by installing a titanium mesh prosthesis which was molded and anchored to the remaining occiput by self-drilling screws and cemented with polymethylmethacrylate.[12] The incision was closed in a standard fashion and Bellis recovered from anesthesia uneventfully.

**RECOVERY AND FOLLOW UP**

During her hospital stay, Bellis experienced a few anticipated post-surgical complications including; pain, thoracic limb hypermetria, pelvic limb ataxia, lateral strabismus in her right eye, and proprioceptive deficits in her left pelvic limb. Through careful management with prednisone (2.5mg PO on a tapering dose), gabapentin (50mg PO TID), tramadol (12.5mg PO TID), and cephalexin (125mg PO TID), all clinical signs subsided within 4 days post-operatively and she was discharged to the care of her owners on 2/10/2008.

On Bellis' two week post-op recheck evaluation (2/22/2008), her owners expressed concern of Bellis' lethargy and wobbly gait after waking up from a nap. She had also developed a "foggy" mentation since surgery and started scratching at both sides of her neck while being very cautious with her movements. On physical examination, Daisy had normal proprioception, withdrawal, and patellar reflexes. She was to discontinue the prednisone, use tramadol only as needed, and continue her gabapentin per usual.

On her two month post-op recheck, 4/4/2008, the owners were happy to report that Bellis' attitude and activity level were improving but she was still itching the back of her head although not as excessively as she once was. Her pain seemed to be well managed while on 50mg of gabapentin PO TID.

Her four month post-op recheck (5/30/2008) revealed a 90% improvement on itching and almost full return to normal function. Gabapentin was discontinued and she was started on pregabalin (11mg PO TID) which, although expensive, seems to have a more potent effect at the $\alpha 2\delta$ subunit of the voltage-gated calcium channels allowing for more reliable control of pain.[6] When asked about what they thought about the success of the procedure, the owners stated they were very satisfied and were happy to have Bellis "back again."

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