THE term syringomyelia (SM) refers to non-cerebrospinal fluid (CSF) filled cavities within the spinal cord. These cavities are thought to develop due to alterations in CSF flow, secondary to multiple chronic diseases of the central nervous system (CNS).

Causes of SM include intervertebral disc protrusions, spinal trauma, tumours and a hereditary malformation where there is overcrowding of the caudal cranial fossa of the skull with brain parenchyma. The latter, termed Chiari-like malformation (CM), results in indentation and herniation of the cerebellum through the foramen magnum and kinking of the brainstem. As the prevalence of SM in patients clinically affected by CM is high, we normally consider this a disease complex (CM/SM).

Any small or toy-breed dog can be affected by CM/SM, including Yorkshire terriers, Chihuahuas, pugs, griffon Bruxellois, Maltese terriers, miniature dachshunds, miniature/toy poodles, shih-tzus, Pomeranians, Boston terriers, French bulldogs and Pekingese.

The cavalier King Charles spaniel (CKCS) is over-represented for CM/SM, for which the disease has a complex oligogenic trait of moderately high heritability. A recent study suggests that 92 per cent of CKCS have at least one morphological abnormality consistent with CM on magnetic resonance imaging (MRI), and we consider this malformation to be ubiquitous in CKCS.

Dogs with clinical signs attributable to CM/SM can present at any age, typically between six months
and three years. Patients affected when young can present with a more severe phenotype of the disease that may be related to hydrocephalus.

**Pathogenesis of CM/SM**

Studies of the pathogenesis of CM/SM have focused on the relative volume of the caudal cranial fossa, part of the cranial vault caudal to the tentorium cerebelli.

Previously, a ratio of the volume of brain parenchyma within the caudal cranial fossa to its bony volume has been shown to be larger in human beings with Chiari type I malformation. Similar volumetric studies in dogs performed at the RVC have found that the brain parenchyma within the caudal cranial fossa of the skull was proportionately the same for CKCS as much larger Labradors, while the bony volume of this region in CKCS was similar to other small-breed dogs. It also appears that a more marked overcrowding of this fossa in CKCS, particularly its caudal aspect, is associated with the presence of SM. One proposed reason for this overcrowding is the recent finding that CKCS may have a large cerebellum, relative to other small dog breeds.

Several theories exist for the development of SM in dogs with CM. The most likely cause is disturbance of CSF flow at the level of the foramen magnum by herniated cerebellum. New imaging techniques using magnetic resonance to measure the flow of CSF have found increasingly turbulent flow in the CSF of affected dogs. A commonly used analogy to describe this phenomenon is the alteration in flow when partially occluding a hosepipe with the thumb. Microscopic damage/fissuring within the spinal cord parenchyma eventually results in the development of fluid-filled cavities.

**Clinical signs**

As the expanding syrinx damages the dorsal horn of the spinal cord, clinical signs tend to be associated with a change of the somatosensory processing of information resulting in the perception of neuropathic pain. Neuropathic pain is different to physiological and inflammatory pain, in that it never benefits an animal and can be considered a disease in its own right.

There are several proposed mechanisms for the development of neuropathic pain, which include altered concentrations of neurotransmitters, such as substance P, and their receptors in the dorsal horn. Neuropathic pain can manifest as vocalisation, reluctance to exercise and fearful behavioural changes that tend to be made worse with anything that raises CSF pressure, such as exercise, coughing and defaecation. Owners often note their pets to be painful when they are picked up. Excessive grooming or “phantom scratching”/“air guitar playing” behaviour is often described and probably represents dysesthesia – spontaneous abnormal sensations (people with this condition describe burning, pins and needles and other strange sensations). Affected dogs occasionally have a trigger spot in the cervical region that, when touched, elicits this behaviour, which may represent a form of allodynia; pain in response to a normal stimulus.
Other clinical signs relate to abnormal postural information – for example, scoliosis, ataxia, muscle wastage and thoracic limb paresis. As the syrinx may be asymmetrical in shape, clinical signs are often lateralised. The lateralising signs may change with time as the developing syrinx becomes more symmetrical.

On clinical examination, cervical spinal pain is the most common finding, but pain can often be elicited along the entire spine, as the distribution of syringes tends to be multifocal along its length. This may raise the suspicion of SM versus more focal causes of spinal pain. Postural reactions may be delayed in affected dogs, particularly hopping tests.

Important differential diagnoses include dermatological diseases, intervertebral disc disease, diskospondylitis, spinal neoplasia, sub-arachnoid cysts, atlantoaxial subluxation and inflammatory CNS diseases, whether sterile, such as granulomatous meningoencephalomyelitis, or infectious, in the case of *Neospora* and *Toxoplasma* myelitis. Occasionally one or more diseases occur concomitantly and may result in acute decompensation (for example, mild SM and fibrous intervertebral disc protrusion), which has implications for managing the condition.

CKCS are also over-represented for primary secretory otitis media (PSOM), a middle ear condition analogous to glue ear in children that can cause head shyness, bulla pain, vestibular signs and, potentially, scratching behaviour that can confuse diagnosis.

**Diagnosis**

Plain spinal radiographs may be useful in ruling out atlantoaxial subluxation, and some causes of diffuse spinal pain that produce lytic lesions, such as multiple myeloma or diskospondylitis. Analysis of CSF typically reveals a mild mononuclear pleocytosis and elevated protein concentration in patients with CM/SM, compared with CM alone. Lumbar myelography can only detect SM when contrast is inadvertently injected into the central canal and, therefore, MRI is a better modality for these cases.

Despite its multifocal nature, SM is most often found with MRI of the cervical spinal cord, but images should include the whole spine if clinically indicated. Imaging features reveal fluid-filled dilatations of the spinal cord that are hyper-intense on T2-weighted images and hypo-intense on T1-weighted images to spinal cord tissue. There is often surrounding oedema evident as T2 hyperintensity. MRI often reveals other related problems, such as enlarged ventricles (ventriculomegaly/hydrocephalus) and intracranial (quadrigeminal) fluid accumulations ("cysts").

Clinical signs are most likely to be observed in association with large, long and asymmetric syringes. Of these, maximum syrinx width and asymmetry are the strongest predictors of pain. However, care must be taken in interpreting these findings because the prevalence of SM in asymptomatic CKCS scanned for breeding purposes has recently been estimated as 25 per cent at 12 months and 70 per cent in dogs aged 72 months or more. It is possible, therefore, this cohort of
patients would develop clinical signs later in life as it is generally considered a progressive disease.

**Treatment**

Unfortunately, there is limited information regarding the treatment of CM/SM in dogs.

Many of the suggested medical treatments are not licensed and the full pharmacokinetic profiles of some drugs are not established in dogs. Much of the information described here is, therefore, based on anecdotal evidence. The prescribing cascade should be adhered to when considering treatment options.

Neuropathic pain does not tend to respond to traditional opioid analgesics and they are not a good long-term solution. In the acute setting, however, methadone may be useful due to its antagonism of the N-Methyl-D-aspartate (NMDA) receptor that is often responsible for CNS sensitisation. Medical treatment is generally aimed at one of three targets.

• **Reducing inflammation**

Spinal cord injury as a result of CSF flow disturbances has an inflammatory component that may be mediated by cytokines or neurotransmitters, such as substance P. There is a rationale, therefore, for treating patients with CM/SM with short courses of NSAIDs or corticosteroids. This seems to be particularly important during the formation phase of a syrinx (in human medicine, often termed presyrinx state) that is particularly painful. As the COX-2 enzyme is upregulated in neuropathic pain, COX-2-specific NSAIDs may be of additional benefit.

A period of strict rest in conjunction with anti-inflammatory medication is advisable for patients in whom mild intervertebral disc protrusion is suspected in conjunction with CM/SM.

Corticosteroids can almost be considered in their own class, as they have several modes of action that include reducing inflammation medicated via the arachidonic acid pathway, reducing neurotransmitter transcription and CSF production. However, their side effects often outweigh the perceived benefits to owners.

Corticosteroids should be considered in conjunction with other oral medications described later if the clinical signs prove difficult to control and surgical treatment is not possible.

• **Reducing CSF production**

Proton pump inhibitors (omeprazole), diuretics (furosemide), carbonic anhydrase inhibitors (acetazolamide) and corticosteroids reduce CSF production and lower intracranial pressure, which may aid in controlling SM-related pain. However, their long-term use is often associated with side effects and metabolic derangements – therefore, they are not recommended as first line treatments.
any more due to the relative success of other treatments.

**Neuropathic pain**

Other than NSAIDs and corticosteroids, some anti-convulsant treatments have benefits in treating neuropathic pain, typically by reducing the release of neurotransmitters, such as glutamate and substance P in the damaged dorsal horn of the spinal cord. The best example is gabapentin, an analogue of gamma aminobutyric acid (GABA). Gabapentin should be initially given at 10mg per kg bodyweight three times daily, which normally results in a significant reduction in clinical signs.

Side effects are rare in dogs, but typically include sedation and ataxia. When sedation is profound, an increased dosing interval to 12 hours can be trialled. Other side effects reported in humans include weight gain and swollen extremities. However, as yet, this has not been displayed in canine patients.

Pregabalin, used at 5mg per kg bodyweight twice daily, is an alternative to gabapentin for non-responders and may even be more efficacious. However, the cost of this drug is often prohibitive for its use in small animal practice. As with most chronic drug therapies, the lowest daily dose required to control the symptoms is ideal.

**Surgical treatment**

Surgery is often advised for children with CM/SM, as in theory, decompressing the foramen magnum by suboccipital craniectomy should restore normal CSF flow and resolve SM.

In addition, patients with hydrocephalus can have CSF shunts placed to facilitate physiological CSF drainage levels, normally from the lateral ventricles to the peritoneal cavity. Several surgical techniques for CM/SM have been described in dogs.

The most commonly employed technique involves suboccipital craniectomy, dorsal laminectomy of the first cervical vertebra and placement of a synthetic cranioplasty over the defect to minimise adhesions. In practice, we reserve surgical treatment for patients intractable to medical treatment, as the current outcome is generally considered variable, with postoperative complications being prevalent in around 47 per cent of the population.

This may be related to important differences in the pathogenesis between humans and dogs that do not result in SM resolution after surgery and are, as yet, undetermined.

**Prevention**

Previously instituted breeding guidelines in CKCS aimed to reduce the prevalence of severely clinically affected CKCS and have appeared partly successful.
One of the main challenges to reducing the prevalence of SM is the previously mentioned likelihood of a young adult dog being asymptomatic when scanned, but suffering progressive clinical signs later in life. The approved breeding scheme for CKCS, implemented by the BVA and The Kennel Club, will hopefully help address this issue. Of great importance to the authors is the eventual development of estimated breeding values (EBV). An EBV mate select programme should allow breeders to select safer breeding combinations in the future. Further information for vets and owners can be found on the canine health scheme pages of the BVA website (www.bva.co.uk).

References

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