Wobbler Syndrome in dogs. Pathogenesis and Diagnosis. Part 1

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Abstract

Wobbler syndrome in dogs refers to a disorder of the cervical vertebrae and intervertebral discs resulting in cervical canal stenosis and spinal cord compression. The main causes of wobbler syndrome are disc associated wobbler syndrome (DAWS) and bone associated wobbler syndrome (BAWS). Clinical signs in DAWS and BAWS are similar but the pathogenesis and the breeds affected are different. Magnetic resonance imaging is the diagnostic test to best define the site, severity, and nature of spinal cord compression, and allows visualization and characterization of lesions within the spinal cord. An early and accurate diagnosis is the critical factor for selecting the best treatment option and to improve the outcome of this devastating disease.

Introduction

"Wobbler syndrome" is the term most commonly used to refer to a canine disorder of the cervical vertebrae and intervertebral discs resulting in cervical spinal canal stenosis and spinal cord compression. However, this term does not indicate a specific diagnosis, but indicates that the patient is affected by a specific set of abnormalities, mainly characterized by a "wobbling gait." and "wobbler syndrome" can also be secondary to other diseases, such as infectious or inflammatory, developmental, acquired (e.g. subarachnoid cyst, syringomyelia), or neoplastic diseases of cervical spine.
The most common underlying causes of "wobbler syndrome" are disc associated wobbler syndrome (DAWS) and bone associated wobbler syndrome (BAWS). However,
In DAWS the cervical spinal canal stenosis (and consequently the spinal cord and nerve root compression) is secondary to intervertebral discs diseases. whereas in BAWS is secondary to vertebral abnormalities.

Etiology

Disc associated wobbler syndrome tends to affect middle aged to older, large-breed dogs, with the Doberman Pinschers being over represented.[1] However, many other breeds (including small dogs), have been reported to be affected by this condition. In one study of 90 dogs, where Doberman Pinschers were excluded, thirty-two breeds were represented. Among these, Labrador Retrievers (13), Dalmatians (13) and Rottweilers (12) were the most commonly affected.[2] Doberman Pinschers may be predisposed to clinically significant cervical spinal cord compression by relative congenital vertebral canal stenosis, with a loss of reserve space.[1] The main factor in DAWS, however, is the underlying chronic degenerative disc disease. The C5-C6 and C6-C7 disc spaces are most commonly affected, with lesions in both interspaces present in about 20% of affected dogs.[3]

Bone associated wobbler syndrome is typically a disease of young adult giant breed dogs, mainly Great Danes and Mastiffs. Cranial cervical vertebrae are more commonly affected and multiple spaces tend to be involved. The main factor in BAWS is a combination of vertebral malformations and osteoarthritic changes of the articular facets.1

Pathogenesis

Disc associated wobbler syndrome

Disc associated wobbler syndrome in dogs shares many similarities with the cervical spondylotic myelopathy in people, and the Doberman breed has been proposed as a natural model to study the disease in humans.[4,5] Although the pathogenesis of DAWS is not well understood, it is thought to be

multi-factorial, and includes primary developmental abnormalities and secondary degenerative changes that lead to vertebral canal stenosis and spinal cord compression. Spinal cord compression in DAWS is typically secondary to a combination of the protrusion of the intervertebral disc and the hyperthrophy or "in-folding" of the ligamentous structures surrounding the spinal cord (dorsal longitudinal ligament, dorsal annulus, interarcuate ligament and joint capsules).

The spinal cord compression is often dynamic, in that the amount of compression changes with changes in spinal position (i.e. elevated vs. flexed vs. turned laterally). It could be that the increased thickness of the surrounding ligament structures is compensatory to an underlying vertebral instability. The collapsed disc space may also cause narrowing of the intervertebral foramina, which in turn may lead to nerve entrapment and spinal artery compression with subsequent radicular pain and decreased blood supply to the spinal cord.[6-8] Generally, these are traction-responsive lesions, in which the degree of spinal cord compression may be reduced by the application of traction to the cervical spine. The dynamic nature of the spinal cord compression is one of the key factors in establishing the diagnosis of DAWS, although not all DAWS are traction responsive. However, interpretation of the traction-responsiveness of lesions is highly subjective and dependent on personal opinion.[9,10] Application of cervical spinal traction re-establishes disc width, flattens the redundant soft tissue structures, and opens the narrowed foramina. In most dogs, 2-3 mm of distraction restores a normal disc width of 4-6 mm.[3]

A somewhat common event in DAWS is the occurrence of a "domino lesion," also called "adjacent segment disease," which is the development of a second lesion at an adjacent disc space after surgical treatment. It is unclear whether the development of this additional lesion is the natural progression of an underlying similar process at the adjacent disc space, or if it is an accelerated degenerative process influenced by the biomechanical effect of fusion at the treated site.[11,12] These stresses can exacerbate any pre-existing subclinical instability and produce either disc extrusion or hypertrophy of annular or ligamentous structures.[13,14] A domino lesion, with recurrence of paraparesis to tetraparesis, develops in up to one-third of dogs after ventral decompression or metal implant insertion and bone cement fixation.[3,14] This is typically reported between 6 months and 4 years after the original surgery, with a mean time to recurrence of approximately 2 years. [10,16,17]

Bone associated wobbler syndrome

The pathogenesis of BAWS is different than in DAWS. Because BAWS is predominantly seen at an earlier age than DAWS, it is thought to be a congenital or developmental abnormality of the cervical vertebrae (particularly in the Great Dane), or secondary to degenerative joint disease of the cervical articular facets and pedicle (particularly in the Mastiff), resulting in progressive dorsal and/or lateral spinal cord compression. **(Fig 1)** At surgery and post-mortem examination of dogs in various studies, incomplete cartilage coverage and asymmetry of the articular process was found.[18] These malformations can result in altered mechanical stresses on the joint cartilage, with subsequent degenerative joint disease and ankylosis.18 Extradural synovial cyst may also be present (more often in the Mastiff) as a complication of the degenerative arthritic facet changes, leading to unilateral or bilateral lateral spinal cord compression. BAWS usually results in a static compression and typically the intervertebral discs are not affected.[1,5]

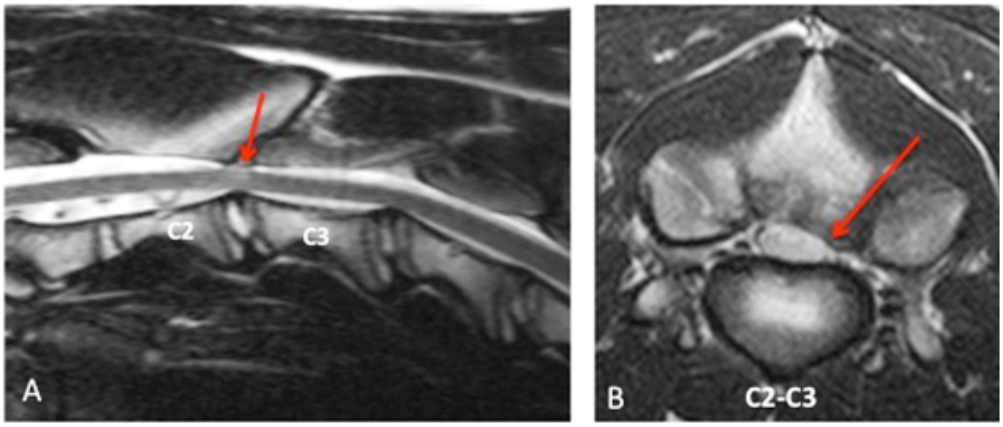

Figure 1a. MRI (T2 weighted) images of a 5 month old Great Dane affected by BAWS. *Sagittal image shows normal disc at C2-C3with appropriate signal intensity. (A) Transverse section at C2-3 shows severe extradural dorso-lateral spinal cord compression and distortion of the spinal cord. The compression is secondary to dorsal arch deformity with articular facets joint degenerative changes (red arrows) with vertebral canal stenosis consistent with BAWS*

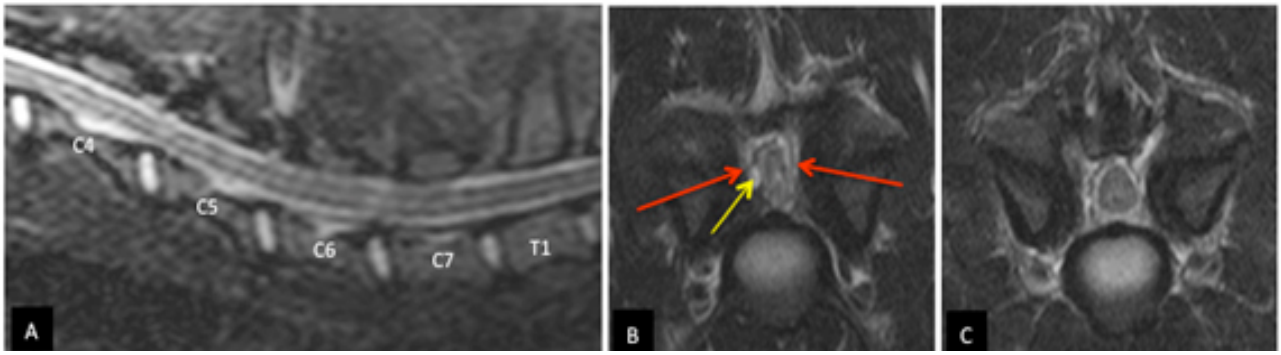

Figure 1b. ***MRI (T2 weighted) images of a 12 month old Mastiff affected by BAWS.*** *Sagittal image shows normal discs with appropriate signal intensity. (A) Transverse section at C6-7 shows severe extradural bilateral spinal cord compression and distortion of the spinal cord. The compression is secondary to articular facets joint degenerative changes with bony proliferation (red arrows) and synovial cyst (yellow arrow) with vertebral canal stenosis is consistent with BAWS.(B) Transverse section at the adjacent cranial disc space (C5-C6) shows a less severe degenerative facets joints changes without spinal cord compression.(C)*

Diagnosis

Clinical signs

Onset of clinical signs in dogs with DAWS is usually between 4 and 8 years of age, while dogs, while dogs with BAWS are usually presented earlier in life. Animals affected with DAWS and BAWS have similar clinical signs, and a chronic progressive history (weeks to months) is the typical presentation. Clinical signs may range from only cervical pain (5-10% of patients) to acute non-ambulatory tetraparesis (10% of patients).[1] Paralysis is usually the acute decompensation of a chronic lesion. Although cervical pain is not commonly part of the presenting complaint, upon careful neurologic exam it is observed in approximately 65% to 70% of Dobermans and 40-50% of other breeds.[1] Decreased cervical range-of-motion, most commonly in dorsi-flexion and lateral flexion, is also typical and it can be evaluated using either gentle manual manipulation or food treat.[1] Deep palpation of the transverse process may also elicit pain. Elbow abduction with internal rotation of the digits ("toe-in" posture) may also be seen in about one-third of Dobermans with DAWS.[1] Proprioceptive deficits may be

seen in all four legs, or may be limited only to the hind legs. The lateral distribution of the afferent proprioceptive pathway related to the hind legs, in contrast to the more medial distribution of the afferent pathway of the front legs, explains why the hind legs are more often affected.[17,19] However, in chronic cases, despite the ataxic gait, proprioceptive deficits may not be detected. This can be explained by the fact that different tracts carry the pathways for conscious and unconscious proprioception.[1]

The most common presentation of DAWS is ataxia, which is more severe in the pelvic limbs, and low carriage of the head. A broad-based stance may be noticed in the hind limbs when the dog is standing. Affected dogs often show a characteristic gait, with the thoracic limbs moving with short stilted steps and the pelvic limbs moving with wide elongated steps. This is also known as a "disconnected" or "2-engine" gait, where the thoracic limbs seem to advance at a different rate than the high limbs. Scuffing of the pelvic or thoracic limb toes/nails also can be seen. The owners commonly report a gradual onset, although the symptoms can sometimes occur or become exacerbated acutely.[1] This disease is usually progressive if left untreated and the prognosis is usually worst for dogs with chronic clinical signs and those with non-ambulatory tetraparesis or tetraplegia.

Survey radiographs

Survey radiographs may be suggestive of DAWS but they are not conclusive. They are used as a preliminary screening to rule out other potential causes of cervical diseases, such as vertebral fractures, subluxations, or tumors, and bone or disc infectious diseases. Survey radiographs in dogs with DAWS may reveal narrowing of the intervertebral disc space, mild deformity of the cervical vertebral body (i.e. rhomboidal shape, vertebral tipping) and spondylosis deformans ventral to the intervertebral space. However, changes on survey radiographs do not always correlate with spinal cord compression and they may be normal in some dogs with DAWS. It has been reported that approximately 20-25% of clinically normal Dobermans have radiographic changes comparable to those seen in dogs with DAWS.[1] Cervical vertebral ratios may be useful as a screening test for dogs with DAWS.[20] Osteoarthrosis and sclerosis of the articular facets at the affected sites may be seen in dogs with BAWS.[1]

Advanced Diagnostic Imaging

Diagnosis of DAWS can be made by myelography, myelography plus computed tomography (CT), or Magnetic resonance imaging (MRI).

Myelography and CT-Myelography

Myelography alone or in combination with CT (CT-myelography), may be considered an option if MRI is not available. (Fig. 5) CT-myelography allows visualization on cross-sectional views of the spinal cord compression and spinal cord atrophy. Spinal cord atrophy may be seen as a triangular shape to the spinal cord and a widening of the subarachnoid space around the spinal cord.[21] As previously described with DAWS, the extent of spinal cord compression can be dynamic and vary with flexion, extension, and linear traction (distraction) of the cervical spine. However, due to the risk of neurologic deterioration from cervical manipulation during general anesthesia, only linear traction myelography or linear traction MRI views continue to be routinely used.[1]

Magnetic Resonance Imaging

MRI is the best and least invasive way to diagnose DAWS and BAWS in dogs. MRI best defines the site, severity, and nature of spinal cord compression, and allows visualization and characterization of lesions within the spinal cord.[9,27] (Fig. 2)

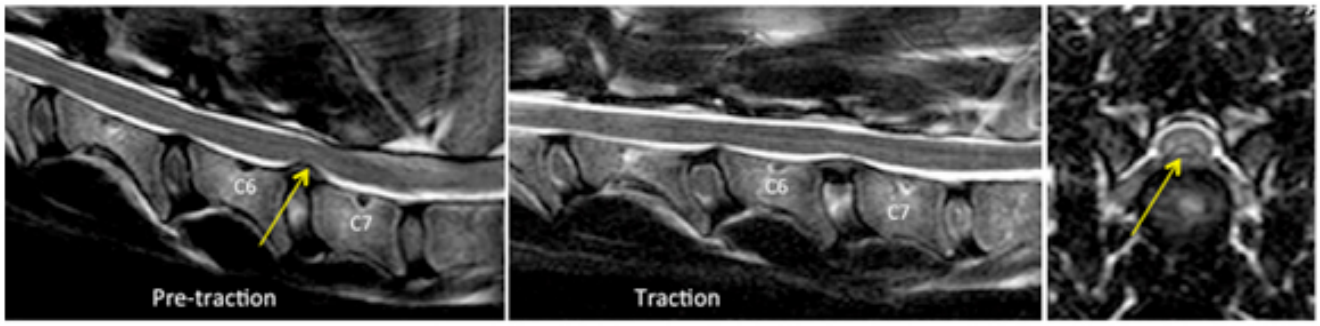

Figure 2. *MRI (T2-weighted) image of a 5 year old Doberman affected by DAWS. Pre-traction sagittal image shows a ventral extradural compression at C6-C7 (arrow). (A) Sagittal image during traction shows improvement in the degree of ventral compression.(C) This lesion is considered dynamic. Transverse section pre-traction at the affected site shows the bulging disc (arrow) causing ventral midline spinal cord distortion.(C)*

Intraparenchymal signal changes are seen in approximately 50% of dogs with DAWS, and provide identification of acute versus chronic lesions.[1] This may be particularly useful not only in establishing severity of the lesion, but also chronology when multiple areas are affected. Hyperintensity on T2-weighted images (T2) usually indicates chronicity and more severe damage to the spinal cord. It is not uncommon in the same patient to detect two or more sites of spinal cord compression and only in one of them see signal hyperintensity on T2. This may be interpreted as the evolution of the same problem at different stages at different sites. Association between spinal cord MRI findings and histologic abnormalities has been well documented in people, and the type of intra-spinal cord abnormalities seen on MRI may be of prognostic value. Hyperintensity on T2 combined with isointensity on T1-weighted images (T1) is usually associated with mild histologic abnormalities, mainly characterized by mild loss of neuronal cells, gliosis and edema in the gray matter, as well as demyelination, edema and Wallerian degeneration in the white matter. In contrast, hyperintensity of T2 combined with hypointensity on T1 are usually associated with more severe histologic changes, mainly characterized by necrosis in the gray and white matter.[28] Hyperintensity on T2 doesn't appear to be correlated with prognosis in dogs, but if it is combined with hypointensity on T1 it may be associated with a worse prognosis.[29]

In DAWS, T2 hypointensity in the disc space reflect dehydration of the nucleus pulposus and disc degeneration, typically associated with various degree of disc protrusion and spinal cord compression. Intervertebral foraminal stenosis may also be seen, and it may play an important role in spinal pain. Interestingly, in some dogs the degree of spinal cord compression may be minimal relative to the severity of the clinical signs. In these patients, the dynamic factor may play an essential role in development of the clinical signs.[1,29]

In BAWS, osseous proliferation from degenerated articular facets, dorsal laminae and pedicles may be visible as hypointense changes on T1 and T2 and the spinal cord compression is best visible on transverse and dorsal views. Synovial cysts may be seen adjacent to the articular facets as a homogeneous area of hyperintensity on T2.[1,24] A dynamic study with linear traction can be performed using the same guidelines described for myelography.[9,24]

Static versus Dynamic lesion

The concept of static and dynamic lesions was first established in 1982.[4] The determination of the "dynamic" or "traction responsive" feature, in contrast to "static" lesions (such as extruded disc material, malformed facets, or deformed vertebral arches), has been suggested as being essential for the diagnosis of DAWS.[22] Guidelines for performance and interpretation of linear traction views (including the way the traction is applied, and the amount and the degree of traction), have been standardized in

two recent studies, which proposed the use of a cervical harness and traction forces not greater than 20% and 25% of the dog's weight, respectively.[9,23] This should generate enough traction force to alleviate traction-responsive lesion causing the spinal cord compression. However, distinction between dynamic and static lesions is very subjective and difficult to determine.[1] A comparative myelographic and MRI study showed that lesions that were considered dynamic on myelography appear static on MRI, and that any compressive lesion either on myelogram or MRI may improve with traction.[9] One major disadvantage of myelography is the potential occurrence of post-myelographic seizures and a temporary worsening of the patient's neurological status.[24-26]

Conclusion

The main causes of wobbler syndrome in dogs are DAWS and BAWS. Although the clinical signs are similar in both conditions, the pathogenesis and the breeds affected are different. Magnetic resonance imaging is the diagnostic test to best define these conditions. The MRI visualization and characterization of the lesions within the spinal cord may also be of prognostic value. An early and accurate diagnosis is the critical factor for selecting the best treatment option and to improve the outcome of this devastating disease.

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