Disc associated Wobbler syndrome in dogs. Part 2.
Treatment and Prognosis

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Abstract:

Bone associated wobbler syndrome (BAWS) and disc associated wobbler syndrome (DAWS) in dogs can be treated either medically or surgically. However, both conditions are considered surgical diseases and medical conservative treatment is associated with a guarded prognosis. While, for BAWS, direct spinal cord decompression through a dorsal laminectomy or hemilaminectomy seems to be the best way to treat this disease process, the ideal surgical procedure for DAWS still has not been agreed upon. Preliminary clinical studies are showing that cervical disc prosthesis may be a valuable method to treat DAWS in dogs.

TREATMENT

Medical treatment

Medical treatment for dogs affected by DAWS and BAWS is similar. Activity restriction and corticosteroids may be indicated in dog with a first episode of neurologic deficits following minor trauma; otherwise, surgery is the treatment of choice. Conservatively treated dogs should have activity restriction for at least two months – they can be walked on leash (preferably attached to a chest harness rather than a collar), but free unsupervised activity should be avoided. This is to minimize high impact activities that could exacerbate the dynamic component of spinal cord compression. Corticosteroids at an anti-inflammatory dose (prednisone 0.5 mg/kg every 12 hours) tapered over 2 to 3 weeks has been recommended.[1] Alternately, dexamethasone (0.2 to 0.25 mg/kg every 24 hours [not to exceed 8 mg/dog] initially for 1 to 3 days depending on the severity of the clinical signs, and then continue with 0.1 mg/kg every 24) has also been recommended.[1] A gastrointestinal protectant such as famotidine (0.5 mg/kg every 12-24 hours) or omeprazole (0.7 mg/kg every 24 hours) may be used in conjunction with corticosteroids. However, due to the many side effects of corticosteroids, their prolonged use is not recommended. Nonsteroidal anti-inflammatory drugs (NSAIDs) may be used when corticosteroids are contraindicated or when clinical signs are limited to cervical pain. The use of corticosteroids is more indicated in patients with more severe neurologic signs (ataxia, paraparesis or tetraparesis), and their ability to reduce interstitial spinal cord edema may have some prognostic value in establishing the reversibility of the spinal cord lesion. Physical therapy and electroacuncture have also been reported. [2,3] Recent studies that evaluated non-surgical or surgical treatments reported that 81% of the dogs treated surgically (via ventral slot, dorsal laminectomy, or distraction and fusion) improved, while 54% and 45% of dogs, respectively, improved with medical treatment.[4-6] In a more recent study, conservative medical treatment provided long-term improvement for only 38% of dogs.[7] These studies concluded that conservative treatment for DAWS is associated with a guarded prognosis.[4-6] Importantly, the neurologic status of dogs at 1 month after diagnosis of DAWS seems to be critical for determining the outcome of conservative medical treatment. In all dogs in which conservative medical treatment was unsuccessful, the neurologic condition had deteriorated at 1 month after diagnosis of DAWS. In these dogs, deterioration of clinical status was generally rapid and progressed to tetraplegia within 6 months after diagnosis.[7] Therefore, evaluation of neurologic condition at 1 month after diagnosis of DAWS is essential in order to identify the patients in which the clinical condition is likely to deteriorate to a non-ambulatory status without surgical intervention. The one-month re-evaluation may be used as a prognostic indicator and for earlier identification of surgical candidates, before the spinal cord damage becomes irreversible.[7]

Surgical treatment

Many surgical techniques have been described to treat DAWS, while the surgical options for BAWS are still limited. The surgical techniques can be broadly divided into three categories: *direct access decompression*, *indirect decompression by ventral distraction-stabilization-fusion* and *direct decompression with distraction and dynamic stabilization*. Reported results for surgical treatment of DAWS are summarized in table 1.

Direct Access Decompression
a) Dorsal laminectomy

This technique is primarily indicated for dogs with BAWS with dorsal or dorsolateral spinal cord compression.[8] Dorsal laminectomy is the least commonly used surgical technique for dogs with DAWS, but it may be indicated for dogs with DAWS with compression in multiple spaces. It can be performed by a continuous dorsal laminectomy (usually from C4 to C7) or by multiple, interrupted single dorsal laminectomies , at the affected site.[8-10] The major disadvantages of this technique are that (a) the ventrally located disk material cannot be removed, and (b) there may be significant, short-term morbidity with deterioration of neurologic status leading to intensive post-operative patient management In one study, which included dogs affected by BAWS and DAWS, post-operative morbidity

was high and 70% of dogs had worsened neurologic status 2 days after surgery. This immediate post-operative decline was attributed to transient instability. This may be a negative factor, particularly in dogs with DAWS, which already have a degree of instability at the affected intervertebral space(s) as part of the disease pathogenesis. Surgical removal of the dorsal portion of the vertebrae and ligamentous tissue may result in further instability that would likely manifest as clinical worsening. However, clinical improvement is expected to follow the initial deterioration as the area re-stabilizes over time. Furthermore, the dorsal approach requires extensive soft tissue dissection, which produces significant tissue trauma and post-operative edema, a contributing factor to the high morbidity.[8] Post-operative complications, including decubital ulcers, seroma formation and recurrence of clinical signs have been reported in 30% of dogs with a mean length of hospitalization of 8.3 days.[8] Formation of a laminectomy membrane at the surgical site may cause restrictive fibrosis during healing, which is mostly responsible for delayed recurrence of neurologic signs.[8] However, in two separate studies, dorsal laminectomy was reported to be successful in providing long-term improvement in the post-operative neurologic status in 19 of 20 dogs and in 11 of 14 dogs, respectively.[8,11] For dogs that become or remain non-ambulatory after surgery, it has been reported to take an average of 2.5 months to regain ambulatory status without assistance. The mortality rate related to euthanasia performed secondary to recurrence of clinical signs is 15%.[8] In the author's experience, dogs with BAWS treated with dorsal laminectomy tend to have a shorter post-operative recovery time and a better outcome than dogs affected by DAWS treated with this technique.

b) Hemilaminectomy

Cervical hemilaminectomy in dogs through a modified lateral approach was reported by Roosmeils et al. to facilitate treatment of lateralized and foraminal cervical spinal lesions associated with BAWS, DAWS, and other cervical spinal diseases.[12] None of the 16 dogs in this study had post-operative deterioration in neurologic status. Outcomes were good to excellent in 2 dogs with BAWS and 1 of the 2 dogs with DAWS. Hospitalization, time to optimal recovery, and overall outcome were not different from previously reported results using other surgical approaches to treat analogous neurologic conditions. Although the long-term follow up was not available for all patients in this study, outcomes were generally favorable.

c) Ventral slot

Ventral slot is the surgical technique commonly used for single site ventral static compression, and there is extensive experience with its use.[1,13] In the standard ventral slot technique, the slot should not exceed one-third of the length and width of the vertebral body **(Fig. 1).** All disc protrusion and hypertrophic ligament should be removed to effectively decompress the spinal cord. The ventral slot technique, when properly performed, offers adequate spinal decompression, and fusion is expected to occur between 8 and 12 weeks after surgery.[1] However, ventral decompression can be technically challenging and can exacerbate vertebral instability. Bleeding from the internal vertebral venous plexus is a major complication of ventral slot decompression and care should be exercised to avoid injuring these structures. If bleeding occurs, it can prolong surgery considerably, can lead to incomplete spinal cord decompression, and if profound may require cessation of the surgery and blood transfusion.[14] Ventral slot decompression may also result in further collapse of the disc space and worsening of the spinal cord compression because of additional in-folding of the ligamentous structures and joint capsules. Post-operative complications occurred in over 20% of DAWS patients treated with a ventral slot.[15,16] Collapse of the intervertebral space can also compress the nerve roots and radicular arteries in the intervertebral foramen, which can cause radiculopathy and focal spinal cord ischemia, commonly manifested as nerve root signature, cervical pain and lameness. Vertebral subluxation and death shortly after surgery have been also reported.[16,17] The recovery rate after standard ventral slot decompression has been reported to be 4 to 6.5 weeks.[14,16] Duration of hospitalization stay and the mean time necessary to reach optimal neurologic status is similar to the dorsal decompression technique.[16] This technique has been reported to be clinically effective, with an average long-term success rate of 72%.[15,16,18] This is most likely attributable to fusion occurring at the treated space post-operatively.[15,19] It is likely that fusion resolves the vertebral instability and promotes the reduction of the remaining thickened ligamentous structures.
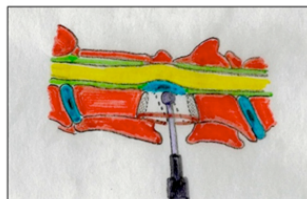

Figure 2. Schematic illustration of the ventral slot technique

INDIRECT DECOMPRESSION

Distraction-stabilization techniques

Several techniques have been described to provide distraction and stabilization for treatment of DAWS. Distraction-stabilization techniques distract the vertebrae to stretch the thickened ligamentous structures and relieve spinal cord compression. The vertebrae are then stabilized with appropriate implants and fusion is promoted with bone autograft (cancellous, cortical or corticocancellous)[4] or allograft.[19] Various techniques have been used to maintain distraction and/or graft retention to allow for bony fusion of the affected interspace.[4,20-28] The principle advantage of these techniques is the immediate relief of spinal cord and nerve root compression achieved by the distraction. Early implant failure with loss of distraction before bony fusion occurs has been the most common cause of failure in distraction-stabilization techniques. The short-term complication rate for the various distraction-fusion techniques has been reported to range from 10% to 21% and it is frequently associated with implant failure.

a) Distraction stabilization using pins or screws and PMMA

This technique is recommended for single ventral dynamic compressive lesions. A standard ventral slot is performed to alleviate the spinal cord compression, prior to the application of 4 smooth or (preferably) positive profile Steinmann threaded pins or fully threaded screws[29] **(Fig 2).** The recommended angle of pin or screw insertion is 30° to 35° for the C5 and C6 vertebrae and 45° for the C7 vertebra.[22, 30] Vertebral stability is then maintained by application of a polymethylmethacrylate (PMMA) bridge that incorporates the pins or screws. In a study by Brucker the long-term success rate was 73%.[22] Bicortical penetration of pins or screws into the vertebral canal with spinal cord damage or vertebral artery or nerve root compromise has been reported to occur in 25% to 57% in experimental studies.[29, 30] Other complications include failure of the bone cement bridges, pins, screws or plates, as well as various soft tissue complications, such as esophageal erosion because of ventral hardware or PMMA prominence.[4]
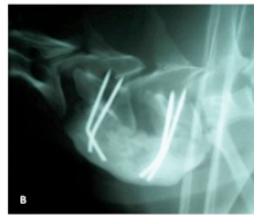

Figure 2. Distraction stabilization by pins and bone cement bridge.

A novel screw-bar-PMMA fixation implant, consisting of screws inserted into the transverse processes and a U-shaped Steinman pin wired to the screw and covered by PMMA has been described in an experimental study.[31] In this study, this technique reduced the incidence of penetration of the transverse foramen or vertebral canal compared with the traditional pin-PMMA implant.

b) Distraction using a PMMA plug.

This technique can be applied for either single or multiple ventral compressions.[4,21] After performing a discectomy, distraction is applied (usually by using a modified Gelpi retractor applied in two pre-drilled holes in the ventral cortex of the affected vertebrae), an anchor hole is drilled into the cranial and caudal endplates, and PMMA, in the semifluid state (i.e. before polymerization), is injected into the slot and in the anchor holes.[20] **(Fig. 3)** Modification of this technique includes placement of a retention screw or pin ventral to the plug.[4] The long-term success rate with this technique is reported to be 82%.[21] Complications may include ventral implant migration and consequently distraction failure. The heat generated during polymerization of the PPMA, or the excessive burring beyond the endplate, may cause endplate necrosis, with intrusion of the PMMA plug into the vertebra and consequently distraction failure. Another disadvantage of this technique is the required application of a well-padded cervical brace for 8 weeks, which has to be replaced every 2 weeks (or sooner if problems arise). This is not well tolerated by some patients.
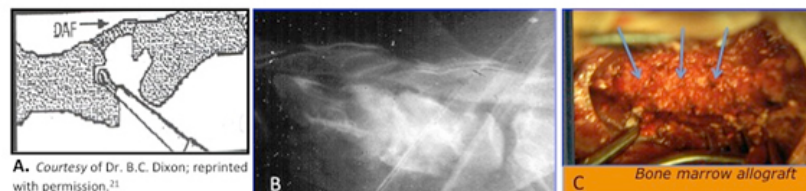

Figure 3. PMMA plug distraction technique.

c) Distraction-stabilization fusion with locking plates and screws.

This technique is indicated for a single-level traction-responsive DAWS lesion. A few approaches to this distraction-stabilization technique have been described.[20,28,32] These include discectomy, distraction of the affected space with a Caspar cervical distractor, inserting in the distracted space either a cancellous bone allograft[20] or a cortical ring allograft to promote fusion[28], and fixing the vertebrae of the affected site in distraction with the Synthes® Cervical Spine Locking Plate (CSLP)

The disadvantages of these techniques are the cost associated with the plate, the screws and the allograft.. Because the ventral aspect of the canine cervical spine tends to have more variation in shape, additional time and technical ability is needed to contour the ventral surface of the vertebral column, through drilling of the bone, in combination with bending of the spinal plate to fit.. For locking plates, minimal contouring is necessary. This is a major advantage of locking implants. The success rate using this technique has ranged from 80% to 83%.[20,28] The overall success rate using direct access or indirect decompression is approximately 80% (70% - 90%).[1]
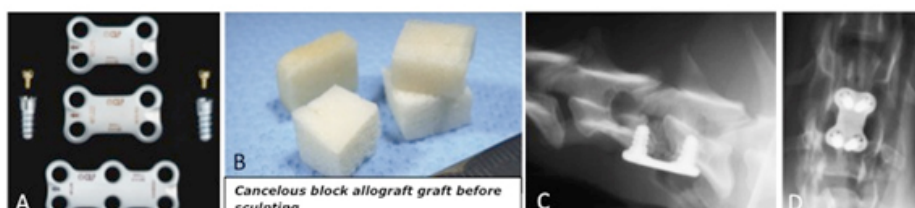

Cancelous block allograft graft before sculpting

Figure 4. Distraction stabilization with locking plate fixation

Domino lesion or adjacent segment disease.

Clinical relapse after initial recovery is a common complication after surgical intervention for DAWS.[4,6,33] These episodes are generally caused by the development of a new compressive lesion on the spinal cord at a disc space adjacent to the surgically treated site.[34] This is commonly known as a domino lesion or adjacent segment disease. The exact etiopathogenesis of this complication is controversial.[35] It is likely that fusion or distraction may increase the risk of a domino lesion. Domino lesions are believed to be the result, at least in part, of abnormal stresses imposed on one intervertebral space by fixation of an interspace adjacent to it. These stresses can exacerbate any pre-existing subclinical instability, and reproduce the same problem at an adjacent disc space[4,36] Others believe that the development of the adjacent segment disease is part of the natural progression of the disease, and if this is true DAWS should be considered a multifocal disease.[35] Recurrence of clinical signs secondary to a domino lesion may occur as a late post-operative complication with any of the above described techniques. Recurrence of paraparesis or tetraparesis occurs in up to one-third of dogs after either ventral slot or metal implant and bone cement fixation, mainly with distraction-stabilization techniques.[1] It usually occurs between six months and four years after the original surgery, with a mean recurrence of around two years.[16,37] A meta-analyis of dogs treated surgically for DAWS revealed an 80% short-term success rate with about 20% of successful surgeries having significant recurrence after long-term follow-up.[35] The type of surgery performed (decompression versus distraction-fusion) did not influence the outcome. Because MRI may allow early identification of the adjacent intervertebral space at risk of developing a domino lesion, treatment of the affected and/or suspected adjacent intervertebral disc space may be recommended in order to reduce the incidence of domino lesions.[4,21,26] Given the high rate of surgical failure and long term recurrence, new methods are continually investigated for the treatment of DAWS in dogs.

DIRECT DECOMPRESSION WITH DISTRACTION AND DYNAMIC STABILIZATION

Cervical disc arthroplasty .

Cervical disc arthroplasty is a novel technique and it is mainly indicated for dogs with DAWS with single or multi-level traction-responsive spinal cord compression. [37,38] The goals of this technique are to provide distraction and greater stability, while preserving motion at the operated site after neural decompression. This technique includes ventral spinal cord decompression via a discectomy, minor burring of the vertebral end-plates (more of the caudal end-plate) to accommodate the implant, and placement of an artificial disc, which is specifically designed and manufactured for the dog's cervical spine[1,37-39] **(Figs. 5).**

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[1]Adamo artificial disc®. Applied Veterinary Technology LLC, San Mateo, CA
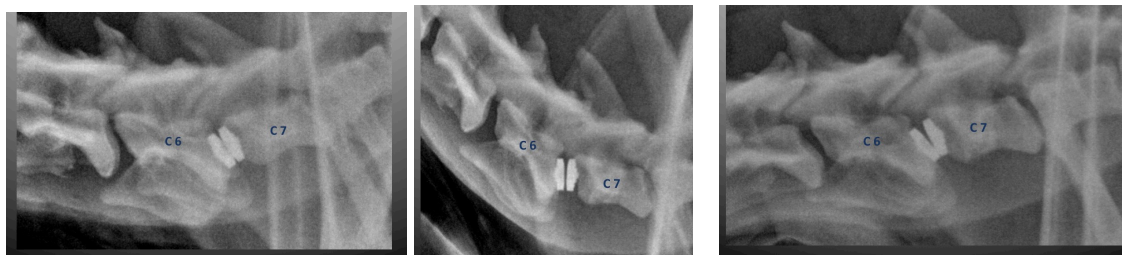
Figure 5. Cervical Disc Athroplasty. Two weeks post-operative radiographs, neutral (left) and stress views (center and right figure) showing maintained distraction and mobility at the treated site.

Cervical disc arthroplasty has the potential to achieve the optimal goals of spinal cord and nerve root decompression, restoration of the biomechanics at the surgically treated sites, sparing the adjacent disc spaces from the alterations in loading associated with the standard ventral slot and distraction-fusion surgical techniques, and potentially preventing the occurrence of a domino lesion. Experimentally, pre-clinical studies of this technique showed that canine cervical spines with this implanted prosthesis had biomechanical behaviors (i.e. flexion, extension, lateral bending, and torsion) similar to an intact spine when compared to cervical spines treated with ventral slot or PMMA distraction-fusion techniques.[39] In two separate clinical studies, cervical disc arthroplasty was well-tolerated and all dogs had immediate post-operative recovery with adequate degree of distraction in the immediate post-operative radiographs.[37,38] In the majority of dogs, the distraction was moderately lost over time; though at a median follow-up of 15 months this was not clinically significant.[38] Cervical disc arthroplasty, similar to ventral slot, allows direct spinal cord decompression at the affected site(s).[37,38] Similar to distraction-fusion techniques, cervical disc arthroplasty provides immediate distraction at the treated site(s), which further decreases any residual compression from the redundant ligamentous structures, and relieves spinal cord ischemia caused by compression of the vertebral spinal artery. The reopening of the narrowed intervertebral foramina further decompresses the nerve roots, eliminating recurrent cervical pain.

Advantages of cervical disc arthroplasty over the standard surgical techniques.
The advantage over the standard ventral slot is that the artificial disc acts as an internal spacer, preventing the early collapse of the intervertebral disc space that is usually associated with ventral slot. The advantage over pins or screws and PMMA distraction-fixation techniques is the elimination of the potential complications associated with pin impingement on neurovascular structures.[37] The advantages over the distraction and fusion with plate and screws are that the artificial disc is a self-anchoring device, and the elimination of the potential complications associated with failure of these implants.[37] Additional advantages of arthroplasty over these technique are that the prosthesis is relatively easy to implant, is cost-effective (its cost may be equivalent to the cost of the pins and PMMA, and significantly less compared to the locking plate-fusion techniques), and can be applied to multiple sites if needed. (Fig. 6) This is particularly important in the event of multiple lesions or when signs of mild spinal cord impingement are evident at adjacent intervertebral disc spaces during MRI.[37] Cervical disc replacement is less invasive than traditional surgeries, reduces the risks and failures of more common surgical techniques, and it is associated with a faster post-operative recovery. Dogs that are ambulatory prior to surgery are expected to be ambulatory after surgery, and thereby this technique can even be performed on an outpatient basis. Possible complications associated with this type of cervical arthroplasty, similar to those reported in humans, include subsidence (sinking of the implant into the softer cancellous bone of the vertebral body), heterotopic ossification and ankylosis at the treated sites, and prosthesis migration.[37,38]
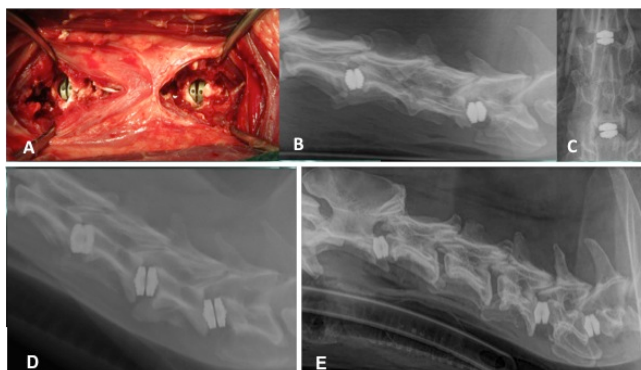

Figure 6. Cervical disc arthroplasty at multiple sites: Two levels non adjacent sites (A, B, C), three levels adjacent sites (D) and three level adjacent and non-adjacent sites (E).

Conclusions

Disc associated Wobbler syndrome and bone associated Wobbler syndrome are relatively common causes of chronic spinal cord compression in adult large breed dogs. DAWS and BAWS are considered surgical diseases. While for BAWS direct spinal cord decompression through a dorsal laminectomy or hemilaminectomy seems to be the best way to treat this disease process, the ideal surgical procedure for DAWS is not yet agreed upon. Preliminary clinical studies are showing that cervical disc prosthesis is a valuable method to treat single and multilevel DAWS lesions in dogs. By preserving the motion segment, arthroplasty represents an attempt to prevent adjacent segment degeneration while treating the underlying disease. Because of the minimal morbidity and many other advantages of this technique, use of cervical arthroplasty may increase owners' willingness to pursue the surgical treatment of their pets.

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