Diagnosis, treatment and prognosis of disc associated Wobbler syndrome in dogs

Diagnose, behandeling en prognose van het discusgeassocieerd Wobblersyndroom bij de hond

[1]S. De Decker, [1]S. Bhatti, [2]I. Gielen, [1]L. Van Ham

[1]Department of Small Animal Medicine and Clinical Biology
[2]Department of Medical Imaging of Domestic Animals
Faculty of Veterinary Medicine, Ghent University
Salisburylaan 133, B-9820 Merelbeke, Belgium

stevendedecker@hotmail.com

ABSTRACT

Disc associated Wobbler syndrome (DAWS) is the most prevalent and most typical Wobbler syndrome in dogs. It is typically seen in the middle-aged Dobermann Pinscher. Caudal cervical spinal cord compression is caused by protrusion of the annulus fibrosus of the intervertebral disc into the spinal canal, sometimes in combination with ligamentum flavum hypertrophy and malformed vertebrae. Clinical signs vary from neck pain to tetraplegia. The diagnosis is generally made using myelography. There is a lot of controversy concerning the treatment of this disease. Many surgical techniques have been developed for it, but little is known about the conservative treatment. Objective data about the prognosis of this disease is scarce.

SAMENVATTING

Het discusgeassocieerd Wobblersyndroom (DAWS) is het meest voorkomende en meest typische Wobblersyndroom bij de hond. Dit Wobblersyndroom wordt vooral gezien bij de Dobermann Pinscher van middelbare leeftijd. Er is een compressie van het caudaal cervicale halsruggenmerg die veroorzaakt wordt door de protrusie van de annulus fibrosus van de tussenwervelschijf in het wervelkanaal, soms in combinatie met hypertofie van het ligamentum flavum en misvormde wervels. De symptomen variëren van nekpijn tot tetraplegie. De diagnose wordt meestal gesteld door middel van myelografie. Er bestaat veel controverse over de behandeling van deze ziekte. Er is weinig bekend over de conservatieve behandeling en er werden reeds veel verschillende chirurgische technieken ontwikkeld om DAWS te behandelen. Over de prognose van deze aandoening bestaan er weinig objectieve gegevens.

INTRODUCTION

Wobbler syndrome refers to a collection of disorders of the caudal cervical vertebrae and intervertebral discs of large breed dogs resulting in spinal cord compression (Van Gundy, 1988). A large variety of lesions with different proposed etiologies have been attributed to the Wobbler syndrome and many synonyms are found in the literature, such as spondylolisthesis (Dueland *et al*., 1973), cervical spinal subluxation and spondylolisthesis (Gage and Hoerlein, 1973), cervical vertebral instability (Mason, 1977; Parker *et al*., 1973), cervical spinal stenosis (Wright *et al*., 1973), cervical spondylopathy (Denny *et al*., 1977), spondylomyelopathy (Read *et al*., 1983) and cervical malformation/malarticulation syndrome (Shores, 1984). All these different clinical entities result in the same clinical signs of ataxia, paresis (predominantly affecting the hind limbs) and cervical pain. The term Wobbler only refers to the characteristic 'wobbling' hind limb ataxia (VanGundy, 1988). The most typical and predominant syndrome is the disc associated Wobbler syndrome (DAWS). This is seen in middle-aged large breed dogs, in particular the adult Dobermann Pinscher. In DAWS, cervical spinal cord compression results from the protrusion of the intervertebral disc between the sixth and seventh cervical vertebrae (C6-C7) and/or between the fifth and sixth cervical vertebrae (C5-C6), and from generally mild vertebral malformations, frequently in combination with dorsal compression resulting from hypertrophy of the ligamentum flavum (Van Gundy, 1988). Approximately 13 to 20% of dogs present with both C5-C6 and C6-C7 lesions at the time of initial diagnosis (Van Gundy, 1988; Sharp and Wheeler, 2005). This article deals primarily with DAWS and reviews the diagnosis, treatment and prognosis of this specific type of Wobbler syndrome.

DIAGNOSIS

Clinical presentation

Animals affected with DAWS are usually 4 to 8 years of age, and Dobermann Pinschers are overrepresented. The most common presentation is a gait disturbance. The owners commonly report a gradual onset, although the symptoms can sometimes occur or exacerbate more acutely. A slowly progressing hind limb ataxia and/or paresis of the pelvic limbs is usually noted. A broad-based stance can be noticed in the hind limbs (Seim, 2000; Wheeler and Sharp, 2005). In dogs with apparently normal thoracic limbs, it is sometimes difficult to distinguish DAWS from a thoracolumbar lesion (McKee and Sharp, 2003).

Progression to thoracic limb involvement with a short stilted gait can also occur (Van Gundy, 1988, Sharp and Wheeler, 2005). Affected dogs often show a characteristic 'disconnected' gait, in the sense that the thoracic and pelvic limbs seem to advance at different rates. Neck pain may be seen but is usually not overtly present: a history of neck pain is seen in approximately 40% of the cases (Seim, 2000). Tetraplegia is uncommon (Sharp and Wheeler, 2005).

Survey radiography

Survey radiographs may be indicative for the presence of DAWS, but they are not conclusive and do not precisely indicate the site of spinal cord compression. This non-invasive technique is useful to rule out potential differential diagnoses such as vertebral fractures, (sub)luxations, vertebral neoplasia and discospondylitis (Sharp and Wheeler, 2005). General anesthesia is necessary to obtain correct positioning of the dog. In dogs with DAWS, changes can be seen in the vertebral body, the vertebral canal and the intervertebral disk space. The altered shape of the vertebrae can range from varying degrees of loss of the ventrocranial border, to a triangularly shaped vertebra. Spondylosis deformans may be seen ventral to the intervertebral space, with associated changes in the opacity of the vertebral body. Narrowing of the intervertebral disk space is frequent and often corresponds to the site of cord compression, although there are exceptions to this (VanGundy, 1988; Lewis, 1991; Sharp *et al*., 1992). The vertebral canal may be stenotic, with the cranial orifice being much narrower than the caudal orifice (Sharp, 1992) (Figure 1). Changes on survey radiographs do not always correlate with myelographic evidence of spinal cord compression (Seim and Withrow, 1982; Read *et al*., 1983, Lewis, 1991). Some dogs with severe radiographic abnormalities will show no spinal cord compression on myelography and demonstrate no clinical signs (Lewis, 1991). Conversely, survey radiographs may be normal in some dogs with DAWS, in which case spinal cord compression is only identified by myelography (Sharp *et al*., 1992). Even when the main site of compression is obvious, secondary sites of compression cannot be identified using plain radiography.

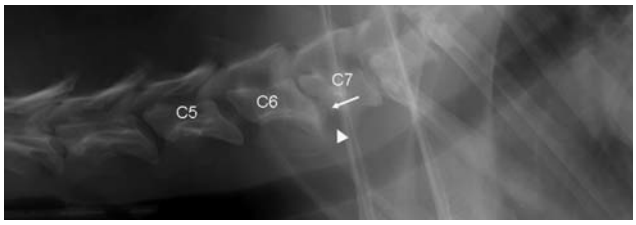


Figure 1. Survey radiograph of a 4-year-old Dobermann. Severe narrowing of the intervertebral disc space between C6-C7 (arrow). New bone formation is clearly visible on the ventral aspect of C6-C7 (arrowhead). Malformation of the cranioventral border of C7.

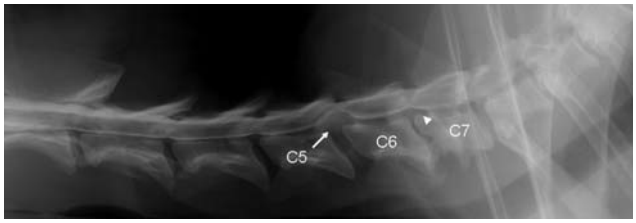


Figure 2. Lateral myelogram of the same dog as in Figure 1. Although the survey radiographs do suggest a compressive lesion between C6 and C7, severe extradural spinal cord compression is noted between C5 and C6 (arrow). A smaller compressive lesion is noted between C6 and C7 (arrowhead).

Figure 3. Myelogram of the same dog as in the previous figures while applying traction on the head. The severity of the compressive lesion reduces remarkably in size with traction. This is a clear example of a traction-responsive lesion.

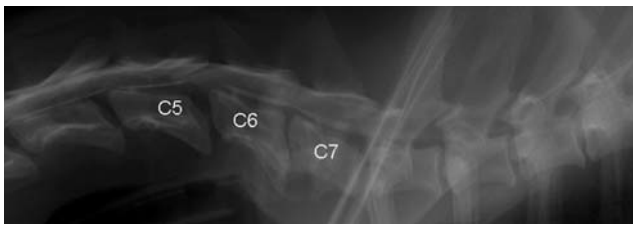
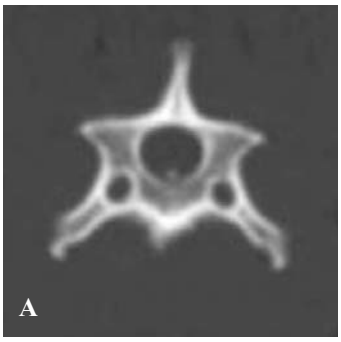
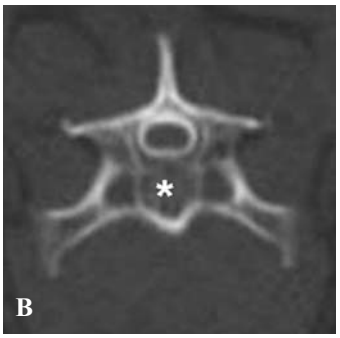


Figure 4. Myelogram of the same dog as in the previous figures while applying flexion on the caudal cervical region. The severity of the compressive lesion reduces remarkably in size with flexion. Extension was not performed due to the potential risk of exacerbation of spinal cord compression.

Myelography

In myelography or contrast radiography, the spinal cord is outlined by a contrast medium injected into the subarachnoid space. Myelography is the diagnostic method of choice for identifying DAWS in the dog





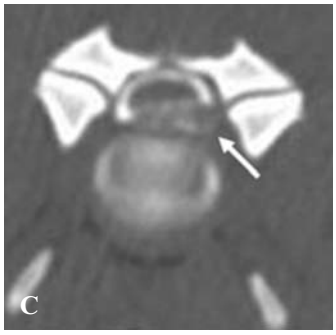


Figure 5A. CT image at the level of the vertebral body of an adult Dalmatian without DAWS. The bony structures are clearly visible. The spinal cord (black) is not visible in this image.

Figure 5B. CT myelography image at the level of the intervertebral disc of the same dog as in Figure 5A. The subarachnoidal space is filled with a radiolucent contrast medium (white). Intervertebral disc (*). The spinal cord (dark) appears round and is surrounded by a subarachnoid space of relatively even diameter.

Figure 5C. CT myelography image at the level of C5-C6 of the same dog as in Figures 1-4. Calcified disc material and a right sided protrusion of the intervertebral disc with severe spinal cord compression (arrow). The spinal cord has a flattened appearance and the ventral subarachnoid space is clearly attenuated.

(Sharp and Wheeler, 2005). In lateral views, abnormalities are seen both in the ventral and dorsal aspects of the vertebral canal (Figure 2). Ventral extradural compression related to the intervertebral disc is the most common finding. The ventral contrast column may be elevated or even arrested in some dogs. Multiple sites of compression are common (Sharp *et al*., 1992). Dorsal compression caused by hypertrophy of the ligamentum flavum is seen in some dogs. This also frequently occurs at multiple sites. The degree of spinal cord compression caused and the clinical significance of this radiological finding are unclear, although some authors believe it is significant (Lyman, 1991). The merit of applying stress during myelography by the use of traction, flexion or extension has been discussed extensively. The degree of spinal cord compression may change as the positions of adjacent vertebrae are altered. Lesions may be categorized based on whether or not compression changes in the 'stressed' positions of traction, flexion or extension. Lesions are termed static when the degree of compression remains the same, whatever the position of the neck, whereas dynamic lesions improve or worsen, depending on the different positions of the neck (Seim and Withrow, 1982). Dynamic lesions can be further subdivided into traction-responsive and positional lesions. This subdivision of lesion types can give some information concerning the nature of the lesion and it helps the surgeon to decide on the best surgical procedure to perform (Sharp and Wheeler, 2005). Traction views are performed by applying tension to the head in a forward direction and to the forelimbs in a caudal direction. Compressive lesions that improve with traction are termed 'traction-responsive' (McKee and Sharp, 2003) (Figure 3). Traction usually decreases spinal cord compression caused by the annulus fibrosus or ligamentous structures (Rusbridge *et al*., 1998). Therefore most dogs with DAWS will show traction-responsive lesions. These traction-responsive lesions can be expected to benefit from distraction-stabilization surgery (McKee and Sharp, 2003). The degree of compression can change as the neck is moved between flexed, neutral and gently extended positions (Sharp *et al*., 1992; McKee and Sharp, 2003). These types of dynamic lesions are termed 'positional', as they are worsened by positions that reflect normal neck motion (Sharp and Wheeler, 2005). Extension usually exacerbates and flexion usually relieves compression in dogs with DAWS (Sharp *et al*., 1992) (Figure 4). Flexion and extension views may be of particular interest in the evaluation of mild lesions, whose significance is unclear when myelography is performed in a neutral position (McKee and Sharp, 2003). Positional studies are not without risk. The extension view can cause severe exacerbation of spinal cord compression and should be done either with extreme care or, in certain cases, not at all (Lewis, 1991). Although myelography is the standard procedure to confirm the diagnosis of DAWS in dogs, this rather invasive procedure is not completely without risk (Sharp and Wheeler, 2005). Seizures and transient neurological deterioration are the most important complications following myelography (Sharp *et al*., 1992). A significantly higher incidence of postmyelographic complications in Dobermann Pinschers with caudal cervical spondylomyelopathy, compared to dogs suffering from other cervical lesions, was demonstrated in the study of Lewis and Hosgood (1992).

Computed Tomography and Computed Tomography myelography

Computed tomography (CT) generates successive cross-sectional images with excellent detail, particularly of the bony structures, which can be reconstructed in different planes (Figure 5A). The reconstruction of these images, for example in a sagittal plane, can be accompanied by a loss of detail (Thomson *et al.,* 1993). Because of its inability to delineate the spinal cord, conventional CT does not

provide as much information as conventional myelography (Sharp *et al*., 1995). When CT is used in combination with a subarachnoidal injection of contrast medium (CT myelography), a good delineation of the spinal cord can also be obtained. An optimal CT myelography (CT-m) image is obtained when a lower dose of contrast medium is used than in a conventional myelographic study (Yu *et al*., 1986). Some resorption and dilution of the contrast agent will naturally occur during a preceding conventional myelographic procedure and usually the two procedures are performed under the same anesthetic episode (Sharp *et al*., 1992). The normal canine cervical spinal cord has a somewhat round appearance and is surrounded by a subarachnoid space of relatively even diameter (Figure 5B). In dogs with DAWS the ventral subarachnoid space is attenuated and the spinal cord appears to be displaced from the floor of the vertebral canal (Figure 5C). These abnormalities are caused by the extradural soft tissue mass of protruding annulus fibrosus. CT myelography may also provide prognostic information by detecting spinal cord atrophy in diseases that cause chronic spinal cord compression. Spinal cord atrophy is characterized by a somewhat triangularly shaped spinal cord and a relative widening of the subarachnoid space, relative to the spinal cord (Sharp *et al*., 1995). There is a strong connection between spinal cord atrophy in humans with cervical spondylotic myelopathy and a poor prognosis following surgery. When the transverse area of the spinal cord is less than 50% of the subarachnoid space, the prognosis is poor (Badami *et al*., 1985; Yu *et al*., 1986). To this day, not one single similar relationship has been studied in veterinary medicine. When used in the immediate postoperative period, CT myelography can be used to confirm adequate removal of a compressive lesion and may demonstrate possible spinal cord re-expansion (Sharp *et al*., 1992).

Magnetic Resonance Imaging

Although this is the technique of choice for imaging humans with degenerative diseases of the cervical spine, there are only a few reports on the use of Magnetic Resonance Imaging (MRI) in the diagnosis of DAWS (Penderis and Dennis, 2004; da Costa *et al*., 2006a; da Costa *et al*., 2006b). MRI allows direct, non-invasive, multiplanar imaging without loss of detail and an excellent soft tissue characterization with an absence of ionizing radiation (Thomson et al., 1993; Lipsitz *et al*., 2001). A distinct advantage is the ability to correctly assess the spinal cord parenchyma. Spinal cord compression, intervertebral disk degeneration, intervertebral disk protrusion and spinal cord signal changes are abnormalities that can be revealed in dogs with DAWS using MRI imaging. Spinal cord compression can be evaluated on sagittal and transverse T2-weighted images as a loss of hyperintense cerebrospinal fluid (CSF) signal around the spinal cord or as a change in shape of the spinal cord from round to oval on the transverse image

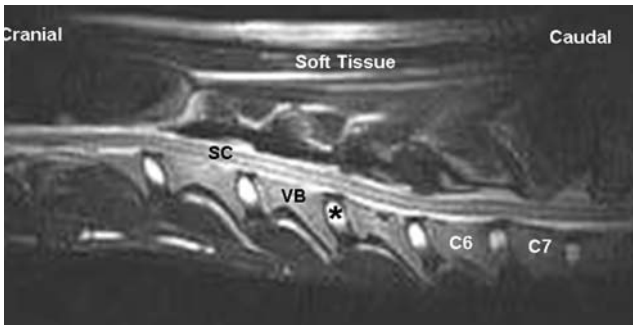


Figure 6A. T2-weighted sagittal MRI image of an adult Dobermann Pinscher without DAWS. Note the excellent soft tissue detail on this MRI image, compared with FIG 5A-C. The spinal cord (SP) is surrounded by the hyperintense subarachnoidal space (white). The subarachnoidal space is visible at each point and never interrupted. VB = Vertebral body. * = a normally hydrated intervertebral disk. Between C6 and C7: partial intervertebral disk degeneration, characterized as a partial loss of hyperintensity of the disk.

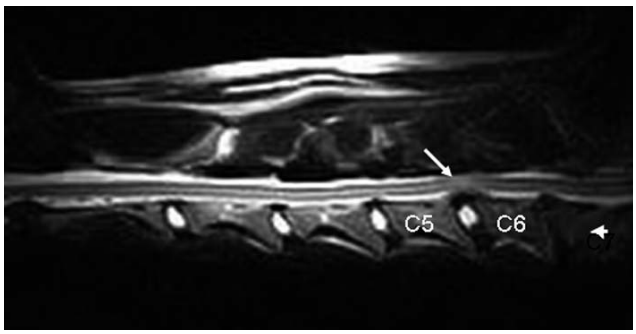


Figure 6B. T2-weighted sagittal MRI image of the same dog as in Figures 1-4 and 5C. At the level of C5-C6 there is complete loss of the hyperintense CSF signal around the spinal cord with subsequent spinal cord compression. A hyperintense area in the spinal cord can be noted at this level (arrow). At the level of C6-C7 there is complete disk degeneration characterized as a total loss of hyperintensity of the disk (arrowhead).

(Lipsitz *et al*., 2001) (Figures 6A and 6B). Intervertebral disk degeneration is characterized by a loss of hyperintensity of the disk on T2-weighted images. Abnormal spinal cord signal changes are classified either as hyperintense or as hypointense when they are compared to the normal spinal cord signal intensity adjacent to the abnormal area (da Costa *et al*., 2006b). Hyperintense T2-weighted signal changes within the spinal cord are a common MRI feature of spinal cord diseases in humans. It is believed that they reflect a broad spectrum of spinal cord abnormalities such as edema, inflammation, vascular ischemia, gliosis and myelomalacia. The exact clinical and prognostic significance of spinal cord signal changes is not yet known (Suri *et al.*, 2003) (Figures 7A and 7B). The possible complications that can be caused by myelography are not caused by the MR imaging, because this technique does not require the injection of a contrast medium into the subarachnoid space. Penderis and Dennis (2004) and da Costa and co-workers (2006b) demonstrated the application of

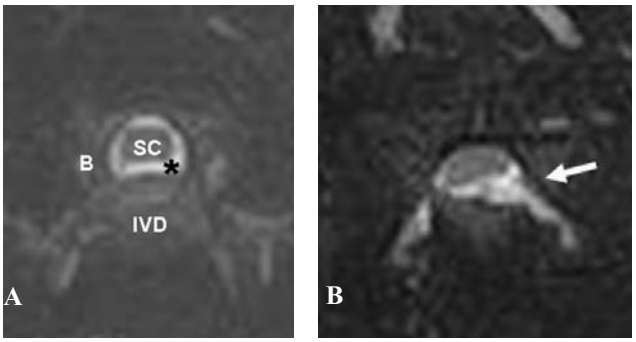


Figure 7A. T2-weighted transverse MRI image at the level of C5-C6 of the same dog as in Figure 6A. The spinal cord (SC) has a somewhat round appearance. The spinal cord is surrounded by a hyperintense cerebrospinal fluid signal (*) of relatively even diameter. IVD = Intervertbral Disk. The spinal cord is surrounded by the bony (B) pedicles.

Figure 7B. T2-weighted transverse MRI image at the level of C5-C6 of a 10-year-old Dalmatian with neck pain and tetraparesis. The spinal cord has an abnormal shape caused by a right-sided extradural spinal cord compression (white arrow). The hyperintense ventral subarachnoid space is attenuated at this level.

traction during an MRI scan to differentiate between traction-responsive and traction-nonresponsive lesions. A possible disadvantage of MRI in the evaluation of the spine is the possibility of over-interpretation, which may result in false positive results. In a recent study (da Costa *et al*., 2006a), 16 clinically normal Dobermann Pinschers underwent MRI imaging. Four of them had spinal cord compression, 12 of them had disk degeneration and, in addition, foraminal stenosis was detected in 11 of them. Mild disk protrusion or herniation was also detected in all of these clinically normal dogs. Spinal cord signal abnormalities, however, were not detected in them. Other disadvantages are the lack of general availability, the high cost and the long time required to complete this kind of study (Sharp and Wheeler, 2005).

TREATMENT

A lot of controversy and discussion exists concerning the treatment of DAWS and the type of surgery that is most likely to give the best results in each individual case (Jeffery and McKee, 2001).

Conservative treatment

There is a lack of knowledge of and objective data on the natural progression of DAWS and of the results of conservative treatment. In the literature, DAWS is often defined as a progressive disease in which surgery is necessary to halt progression of symptoms (Sharp and Wheeler, 2005; McKee and Sharp, 2003). The study by Denny and colleagues (1977) is often cited to provide evidence that conservative therapy is ineffective in the treatment of Wobbler syndrome. This paper described 35 cases of cervical spondylopathy with follow-up records of 10 surgically treated and 25 untreated animals. In the group of the untreated animals only one dog could be suspected of having DAWS, based on his signalment and radiographic abnormalities, and this animal was lost during follow-up. The study dealt almost exclusively with the specific type of Wobbler syndrome that typically affects immature Great Danes and Dobermanns. This syndrome is associated with vertebral malformation-malarticulation and has a different etiology and prognosis than DAWS. Although objective results are not available, it is possible that conservative treatment could be successful in certain cases. Conservative treatment would consist of cage confinement for several weeks in combination with inflammatory drugs when needed. If the initial cage confinement is successful, the patient should gradually return to normal activity over the course of 4-6 weeks. Intermittent inflammatory drug therapy may be necessary (McKee and Sharp, 2003; Sharp and Wheeler, 2005). One study describes the successful application of physiotherapy as the sole treatment for three dogs with chronic disc associated compressive lesions of the caudal cervical spinal cord (Speciale and Fingeroth, 2000).

Surgical treatment

Several surgical procedures have been described to treat DAWS. Although many authors claim their procedure has a success rate of between 70% and 90%, the large number of reported techniques reflects the difficulty of treating DAWS (Chambers *et al*., 1982; McKee *et al*., 1990; Dixon *et al*., 1996; Rusbridge *et al*., 1998; de Risio *et al*., 2002). All surgical procedures for the treatment of DAWS have a high potential for morbidity and postoperative complications (VanGundy, 1988; Sharp and Wheeler, 2005). There are three basic types of surgery: ventral decompression, vertebral distraction-stabilization and dorsal decompression (Sharp and Wheeler, 2005). The main factor governing the choice of surgical procedure is the appearance of the spinal cord on imaging, in particular the traction views after myelography. Other factors include the number of sites of spinal cord compression, the degree of vertebral malformation and the presence of nerve root compression (thoracic limb lameness) (McKee and Sharp, 2003).

Ventral Decompression

Ventral decompression by a standard ventral slot technique is, according to several authors, appropriate for single, static lesions (Seim, 2000; McKee and Sharp, 2003; Sharp and Wheeler, 2005). Ventral decompressive surgery can be very challenging for dogs with DAWS because of the possibility of vertebral malformations, limited access to the caudal cervical disc spaces and intraoperative bleeding due to possible adhesions between the hypertrophied annulus and venous plexus (McKee and Sharp, 2003; Sharp and Wheeler, 2005). It is very important to remove all of the compressive dorsal annulus and dorsal

longitudinal ligament. This can be very difficult to do in chronic compressive disorders like DAWS. The two main disadvantages of this surgical technique are the inability to perform surgery on two adjacent disk spaces and the inability to treat dorsal compression due to ligamentum flavum hypertrophy (McKee and Sharp, 2003; Sharp and Wheeler, 2005). Short-term deterioration is common, even among dogs that have good long-term results (Rusbridge *et al.*, 1998). It is very difficult to interpret and compare reports on the results of ventral decompressive surgery due to the large differences in inclusion criteria and follow-up periods for the different authors. Chambers and colleagues (1982) only included dogs which had a survival of at least one year after surgery in their report. In this way they ignored the dogs that were euthanized in the first year after surgery due to lack of postsurgical improvement. They reached a 100% success rate in this study. In a later study they also included dogs that died postoperatively due to problems unrelated to DAWS. In this study they reached a success rate of 66% (Chambers *et al*., 1986). In the study by Rusbridge and colleagues (1998), cases were excluded if a minimum follow-up period of 24 months after surgery could not be reached. For this reason, six dogs were excluded from the study and 4 of the remaining 14 dogs demonstrated a recurrence of clinical signs two years or more after surgery. This last piece of information demonstrates the most important complication in applying ventral decompression to dogs with DAWS. It is commonly believed that about 20% to 30% of the dogs undergoing single level decompression suffer a second episode of neurological signs within 2-3 years (Bruecker *et al*, 1989; Rusbridge *et al.*, 1998). The reason for this neurological deterioration is presumed to be a recurrence at the original site or the development of a compressive lesion at an adjacent disk space, which is called a domino lesion (Wheeler and Sharp, 2005). This occurs independently of the surgical technique performed, also after distraction-stabilization techniques (Jeffery and McKee, 2001).

Vertebral distraction-stabilization

The primary indications for a distraction-stabilization procedure are the presence of a traction-responsive lesion on myelography and the presence of nerve root compression. A number of different techniques have been developed for this procedure, such as vertebral distraction and stabilization with vertebral body pins or screws and bone cement (Bruecker *et al*., 1989), a screw and washer (McKee *et al.*, 1989), a screw and double washer (McKee *et al.*, 1990), interbody bone cement plug (Dixon *et al*., 1996) and the Compact Unilock System (Voss *et al*., 2005). All of these different surgical techniques are based on the same principle. A ventral slot defect is drilled to a depth of three-quarters of the height of the intervertebral disk space. In this way the dorsal annulus is preserved and the vertebral canal is not entered into. Traction is applied to the adjacent vertebrae using vertebral distraction instruments or by manual traction on the head. The two vertebrae are then rigidly stabilized with an orthopedic implant to maintain distraction. Linear traction provides immediate cord decompression by stretching the dorsal annulus, dorsal longitudinal ligament and ligamentum flavum. By stabilizing the adjacent vertebral bodies, it is assumed that the hypertrophied soft-tissue structures would then be allowed to atrophy with time. The advantage of not entering the vertebral canal, as is done in direct decompressive surgical techniques, is offset partly by the risk of implant failure or other implant-associated complications such as loosening, migration or breaking of implants, vertebral end-plate fracture due to inadequate contact between the orthopedic implant and the vertebral endplate, and the increased risk of surgical infection. Implant failure can be asymptomatic in some patients (Sharp and Wheeler, 2005). As in other surgical techniques, it seems to be very difficult to perform surgery on more than one intervertebral disc space at the same time. Domino lesions occur with the same incidence with this technique as with ventral decompressive surgery. The two most recommended techniques are the interbody bone cement plug and vertebral body pins combined with bone cement (Seim, 2000; McKee and Sharp, 2003; Sharp and Wheeler, 2005).

Dorsal decompression

Dorsal decompression by dorsal laminectomy is normally used to relieve compression caused by dorsal lesions that do not respond to traction. Such compressive lesions are usually seen in young adult large-breed and giant-breed dogs suffering from a Wobbler syndrome, in which the compression is caused by articular and periarticular tissue proliferations, often in combination with ligamentum flavum hypertrophy (McKee and Sharp, 2003; Sharp and Wheeler, 2005). Although this technique is not often used in the treatment of DAWS, several authors have reported a continuous dorsal laminectomy extending from C4 to C7 for dogs with ventral lesions at multiple intervertebral spaces. In this way, spinal cord compression is alleviated by allowing the spinal cord to ride dorsally (Lyman, 1991; De Risio *et al*., 2002). The major disadvantages of dorsal decompression are the invasiveness of the surgical technique, which can be associated with significant short-term morbidity, transient deterioration in neurological status and prolonged length of hospitalization. Also, the technique does not allow the removal of ventrally located disc material (VanGundy 1988; De Risio *et al*., 2002). A possible complication is the recurrence of clinical signs. This is not caused by a domino lesion but rather by the formation of a laminectomy membrane at the surgical site, which is also termed constrictive fibrosis (De Risio *et al.*, 2002). It is very difficult to interpret the reported results of dorsal decompressive surgery for the treatment of DAWS, as it is not stated whether the compressive lesions treated were ventral or dorsal in nature (Lyman, 1991; De Risio *et al*., 2002).

PROGNOSIS

There is little objective data available on the prognosis of DAWS. Even though there is not a single specific report on the natural progression or medical treatment of dogs with DAWS, neurological and surgical handbooks do describe a generally guarded to unfavorable prognosis for patients treated medically (Seim, 2000; McKee and Sharp, 2003; Sharp andWheeler, 2005). In surgical reports, many authors claim a success rate of more than 70% or 80% immediately postoperative (Bruecker *et al.*, 1989; McKee *et al.*, 1989; McKee *et al.,* 1990; De Risio *et al.*, 2002). Conversely, overall long-term mortality rates vary from 19% to 43%, which suggests a less favorable prognosis (Dixon *et al*., 1996; Rusbridge *et al*., 1998, McKee *et al*., 1990; De Risio *et al*., 2002). After both ventral decompressive and vertebral distraction-stabilization techniques have been applied, a second episode of clinical signs is seen in about 20% to 30% of the cases (Jeffery and McKee, 2001; McKee and Sharp, 2003, Sharp and Wheeler, 2005). It is very difficult to compare the results of the different surgical techniques due to the differences in case selection, in the definition of a successful outcome and in the length and descriptions of follow-up (Jeffery and McKee, 2001). Most surgical reports deal with the 'Wobbler syndrome in general' and do not focus on DAWS in particular. This could give the false impression of a favorable outcome because the surgical treatment of the Wobbler syndrome typically seen in young adult giant-breed dogs gives better results than the surgical treatment of DAWS (McKee and Sharp, 2003). Generally, patients with multiple lesions have a guarded to unfavorable prognosis (Seim, 2000; Jeffery and McKee, 2001; McKee and Sharp, 2003; Wheeler and Sharp, 2005). The most plausible reason is that, when applying one of the current surgical techniques, it is very difficult to perform surgery on two adjacent disc spaces at the same time. Other potential prognostic factors are the degree of neurological dysfunction, the duration of clinical symptoms before diagnosis and the rate of spinal cord compression (Jeffery and McKee, 2001; McKee and Sharp, 2003; Sharp and Wheeler, 2005). Patients with severe neurological dysfunction and a long period of clinical signs may have a more guarded prognosis. In some cases, surgery will only halt the progression of the disease. In these cases, irreversible spinal cord damage has probably already occurred. Several authors suggest the use of advanced medical imaging, such as CT myelography and MRI, as a prognostic tool to diagnose spinal cord atrophy (Sharp *et al*., 1995; Jeffery and McKee 2001). A possible correlation between the diagnosis of suspected spinal cord atrophy and a poor outcome has not yet been investigated in veterinary medicine.

CONCLUSION

Disc associated Wobbler syndrome is a relatively common cause of chronic spinal cord compression in adult large breed dogs. This disease can be very challenging, both for the referring veterinarian and even for the specialist. One of the key problems is the variation in definitions of and discrimination between this and other Wobbler syndromes. Making a diagnosis is not always straightforward, and the advantages and disadvantages of the different diagnostic procedures should be considered. DAWS is considered a surgical disease but the ideal surgical procedure still does not exist. Conversely, there is insufficient knowledge about the conservative treatment and natural progression of this disease and, in addition, there is insufficient objective data available on the potential prognostic parameters of this disease. It seems quite clear that further studies are needed to deal with the aforementioned problems.

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