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SURGICAL TREATMENT OF LUMBOSACRAL FORAMINAL STENOSIS

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Degenerative lumbosacral stenosis (DLSS) in dogs involves numerous soft and bony tissue alterations, coupled with or caused by suspected instability of the lumbosacral region causing impingement of nerve roots and associated vasculature at different levels. Compressive radiculopathy of the L7 nerve root has been recognized as an important feature of the disease in early investigations. While stenosis of the lumbosacral canal is well recognized with conventional radiographic techniques such as myelography and/or epidurography, recognition of foraminal stenosis has increased since the introduction magnetic resonance imaging (MRI). Consequently, this condition needs to be specifically addressed by surgical techniques as with standard dorsal laminectomy access to the lumbosacral foramen is limited. The lumbosacral lateral foraminotomy we describe here was developed to directly address the pathologic conditions within and lateral to the L7/S1 intervertebral foramen, in order to preserve the articular facets and to maintain segmental motion. Clinical findings in dogs with unilateral foraminal stenosis alone were relatively easy to localize after exclusion of orthopaedic causes for the lameness. In accordance with human neurology we assume that the lameness observed in our cases is mainly of sensory origin and resembles radiating pain12,13. Mixed signs of cauda equina compression and radiculopathy of the 7th lumbar nerve root may occur concomitantly. Specific identification of affected nerve roots was not possible in these cases because compression of the S1 root at the lumbosacral junction may result in identical clinical signs as a lesion of the 7th lumbar nerve root. Both nerve roots supply the myotomes of the sciatic nerve and its branches.

Diagnostic imaging is the key element in defining the surgical approach. Both, CT and MRI are able to demonstrate foraminal pathologies with each having its specific benefits and limitations. While CT is superior to demonstrate compressive lesions of bony origin, MRI provides useful information on disc pathology and morphology of the cauda equina nerves. The present author is in favour of MRI despite of the difficulties in discriminating tissues of low signal intensity such as fibrous and bony structures because the extent of foraminal stenosis can be assessed more accurately with this modality even if it is not of bony origin (and this occurs frequently!).

The dog is positioned in ventral recumbency with the hind limbs slightly flexed and rotated in an angle of approximatively 20 degree away from the surgeon to improve visualization of the foraminal exit zone. The skin is incised from L6 spinous processus to S2 on the dorsal midline. The superficial truncal fascia is incised in the same manner and subfascial fat is cleared away laterally to the level of the ilial wing and retracted with the aid of gelpi retractors. The deep truncal fascia is incised about midline between the ilial wing and the spinous processes between L6 and S2. Blunt penetration of the fascial cleft between the multifidus and sacrocaudalis muscles is performed. The muscles are retracted and sharp dissection is used to remove the muscles attaching the articular processes caudal to L6/7 and cranial to L7/S1. Blunt preparation is continued down to the level of the transverse process and to the level of the intervertebral foramen L7/S1 using a peristostal elevator. Partial removal of the m. quadratus lumborum and longissimus with rongeurs may be necessary for full exposure of the transverse process and pedicle of L7. The position of the ilial wing allows instrumental and visual access to the lumbosacral foramen in a dorso-oblique direction only. Foraminotomy is performed using a bur drill. In a vertical direction, the drill hole ranges from the dorsal aspect of the transverse process to the base of the cranial articular process of L7. Horizontally, the foraminotomy extends from the caudodorsal origin of the transverse process into the exit zone of the IVF. The bone is drilled away to the inner cortical layer. After opening of the lateral spinal canal (entrance zone of the spinal nerve) and the L7-S1 intervertebral foramen beneath the articular facet, a blunted probe is used to outline the extension of the canal. The foraminotomy is then extended in cranial and dorsal direction if necessary with fine burrs (2-4 mm) and the use of a 2 mm Ferry-Smith-Kerrison rongeur while protecting the nerve root with a small retractor. Osteophytes or soft tissue are removed using small rongeurs. The procedure is considered to be complete, when the nerve root is free of any impingement and moveable a few millimeters in a lateral and cranial direction with gentle traction using a nerve root hook.

The most peripheral part of the intervertebral foramen is difficult to depict if the physiological surrounding of soft tissues of low signal intensity such as fibrous and bony structures is not available. The extent of foraminal stenosis can be assessed more accurately with this modality even if it is not of bony origin (and this occurs frequently!).
The term "wobbler’s syndrome" includes various diseases of the caudal cervical segments of large dogs. All of these disorders result in compression of nerve roots, spinal cord and vasculature and the clinical consequence is a gait disturbance that has a "wobbly" appearance. Vertebral malformation and degeneration of the cervical disc are the most common causes of the syndrome. Oftentimes, the combination of disc degeneration and protrusion, vertebral subluxation and thickening of the ligamentum flavum compress the spinal cord. Affected levels include C5-6 and, more often, C6-7.

The large number of reported techniques for this condition reflects the difficulties of managing the disease. Direct decompression (dorsal laminectomy, ventral slot, hemilaminectomy/Foraminotomy), indirect decompression (vertebral distraction-stabilisation) and vertebral stabilisation without distraction have been described to be effective. Which technique is superior over the others in a given case cannot be determined due to lack of evidence-based studies. There is even no scientific prove that surgical treatment is superior to non-surgical management.

Non-surgical treatment
In a recent study including 51 dogs with disc-associated wobbler’s syndrome (DAWS) were treated with prednisone over 3 weeks with an initial dosage of 1mg/kg once daily and reduction of the dosage every week of treatment. In addition, dogs were confined to the leash and a harness was used. In 45% of dogs this management was graded as successful after 1 year. In the group, that did not improve, 85% of dogs were euthanized due to progression of their disease within one year. (De Decker et al, 2009). In another study, Da Costa et al (2008) results of conservative treatment were more successful with 54% of dogs that improved, 27% that remained the same and only 19% that worsened in their neurological function within one year (n=67).

Direct decompression techniques
Advantages of these procedures include the absence of implants with all their inherent risks of failure and cost and that they are less likely to cause adjacent segment disease (domino lesions). The main disadvantage is the altered motion of the operated segment. Beside possible pain the worst case scenario herein is vertebral luxation or subluxation both of which require revision surgery. Further, degeneration of the operated segment is not halted and recurrence of neurological dysfunction is possible.

Removal of a protruding disc via ventral slot is the most common procedure in the neck. Reported success rates of this technique in dogs with DAWs vary between 58% (Rusbrigde, 1998) and 81% (Bruecker et al, 1989).

References:

TREATMENT FOR CAUDAL CERVICAL SPONDYLOMYELOPATHY – DECOMPRESSION, STABILIZATION, FUSION
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Continuous dorsal laminectomy has been recommended in dogs with multiple cervical disc protrusions. Initial success rate in 8 dogs was 100% at 16 months but later on went down to 80% at 45 months.

Cervical hemilaminectomy has been described to be effective in 3/4 dogs (Rossmeisl, 2005). In our experience, this procedure was successful in 5 dogs while in 2 dogs no improvement was observed following surgery (Schmied et al. 2011).

**Indirect decompression techniques**

It is the main advantage of these procedures that the spinal canal is not opened resulting in a lower risk for iatrogenic injury to nervous and vascular structures. On the other hand, placement of implants through safe corridors to avoid the aforementioned structures requires good anatomic orientation of the surgeon. Locking plates are comparably easier to apply as pins or screws to hold PMMA bridges in place as their screws do not need bicortical insertion.

The general goal of these procedures is elimination of the stenosis within the spinal canal by distraction of the vertebrae. Thereby, ligamentous structures including a protruding disc and/or ligamentum flavum are stretched. Widening of the spinal canal diameter indirectly decompresses spinal cord, nerve roots and associated vasculature. Several devices have been described to maintain the distraction including locking plates or PMMA bridges at the ventral aspect of the spine, intervertebral placement of PMMA plugs, washer’s, autologous or heterologous bone grafts, cages). While PMMA bridges anchored to the vertebrae with pins or screws have been used since decades, more recently locking plates in combination with bone substitutes or cages have been used. Not all of these procedures result in bony fusion of the stabilized segment. True fusion means crossing of solid bone from endplate to endplate. This has been achieved with a hollow interbody cage containing autologous bone graft.

Further advantages include halting of progressive degeneration of the stabilized segment. Follow-up imaging studies have shown that elimination of abnormal segmental motion may result in regression of soft tissue proliferations and remodelling of bony structures.

While infections and implant failure represent rare complications the main problem of stabilizing procedures is adjacent segment degeneration (ASD) aka domino lesion. It has been observed in 20-30% of cases that have had stabilization of their cervical vertebrae. It can occur several years after the procedure. Managing this complication is challenging and almost certainly requires additional stabilization of the newly affected segment. ASD is one of the main reasons why functional intervertebral disc replacement (disc prosthesis) have been introduced into human neurosurgery. Maintenance of segmental motion is hoped to reduce mechanical stress on adjacent segments thereby reducing accelerated degeneration. However, a recent randomized clinical study in humans demonstrated that disc arthroplasty did not reduce the incidence of AJD compared with spinal fusion procedures (Jawahar et al., 2010). In dogs, a recent case report using disc arthroplasty has demonstrated that segmental mobility can be achieved only transiently. After several months the operated segments became immobile as demonstrated with radiographic follow-up studies (Adamo, 2011).

Summarily, there are advantages for both direct and indirect decompression procedures. The success rate for both types of surgical management circles around 80% regardless which specific procedure is used. As caudal cervical spondylomyelopathy is a progressive disorder the role of medical management seems to be more a transient than a long-lasting solution. Diagnostic imaging is important to define the morphology and the differentiation between dynamic and static stenosis. This parameters allow the surgeon to tailor the available treatment options for the individual patient. Which of the presented therapies is most effective can only be answered with the aid of comparative, randomized studies including a large number of dogs and using the same standards. As these results are not available (yet) the best choice of treatment has to be based upon information of the patient and the experience of the treating veterinarian.

References:

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NEUROLOGY

NEWER ANTI-EPILEPTIC DRUGS - MORE THAN JUST PHENOBARBITAL AND POTASSIUM BROMIDE?
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Idiopathic epilepsy (IE) is the most common chronic neurological disorder in dogs. Since decades, its treatment consists of long-term administration of Phenobarbital or Potassium bromide or a combination of both. The maximum goal of treatment is the achievement of a seizure-free status without side effects. Ideally, only one antiepileptic drug (AED) is administered. In reality, in only 30% of epileptic dogs treatment is effective enough to obtain this result. As a consequence, in a majority of dogs reduction of seizure frequency, severity of the seizures and their duration can be defined as successful therapy. In 20-30% of dogs, antiepileptic treatment is not successful with some dogs developing drug resistant epilepsy. Etiologies of drug resistant epilepsy are numerous, complex and, therefore, rarely evident in the individual dog. Possible mechanisms include progression of the disease, increased clearance of the drug from the neuronal membrane, loss of drug receptors and sprouting of new epileptogenic synapses.

Management of drug resistant epilepsy is challenging. Increasing the dosage of Phenobarbital and potassium bromide is limited by the side effects of both drugs including polyuria, polydipsia, ataxia, hepatotoxicity, sedation and bromide intoxication. Consequently, the use of newer AED agents represents an attractive opportunity. New AED have been successfully introduced in the management of humans with epilepsy and their efficacy has been proven in clinical trials. The veterinarian has to be aware, that some of these drugs (i.e. vigabatrin, lamotrigin, oxcarbazepin) cannot be used in dogs and cats because of their pharmakinetics and life-threatening side effects. On the other hand, some of the newer AED's have been used in animals and some of these will be discussed in this presentation.

When shall I use new AED?
The answer is associated with the definition of successful seizure control and the criteria in veterinary medicine are not rigid. A change in pharmacological seizure management is indicated when seizures recur with high frequency (>1 seizure/3 months) despite a combination of Phenobarbital and Potassium bromide or if there are clusters of seizures or status epilepticus despite adequate blood concentration of the drug.

Can new AED be used as monotherapy?
This question has not been addressed so far. In all publications new AED’s have been used in combination with one or both standard drugs. There are anecdotal reports about successful management of epilepsy in dogs and cats (zonisamid in dogs, levetiracetam in cats). However, without scientific evidence this cannot be recommended for routine use at the moment. As new AED appear to have fewer side effects monotherapy represents an attractive option. However, due to lack of long follow-up results this benefit may not hold true on long term.

It is not known, how many dogs and cats with epilepsy refractory to treatment with standard drugs are successfully managed with newer AED’s. In human epileptology, only 3% of patients refractory to a single
drug became seizure free after a change of medication to 2 or 3 AED’s. Personal experiences indicate a similar situation in veterinary patients. However, some patients can be managed successfully with newer AED’s. Systematic analysis of clinical results about efficacy of newer AED’s are necessary to draw meaningful conclusions. A recent meta-analysis evaluating three different prospective, placebo controlled clinical trials with different AED found that 22 out of 28 dogs that received placebo had a reduction in seizure frequency. Eight dogs were even classified as “responders” because their reduction in seizure frequency was > 50%. This study demonstrates, that we should be cautious with the interpretation of all open-label studies investigating clinical efficacy of newer AED’s. Only when these drugs have been evaluated in placebo-controlled studies there is true evidence for their efficacy.

References:
- Volk H et al. The efficacy and tolerability of levetiracetam in pharmacoressistant epileptic dogs. The Veterinary Journal 2007, 300-319

Table 1: new antiepileptic drugs

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosage</th>
<th>Time to reach steady state</th>
<th>Therapeutic concentration</th>
<th>Excretion</th>
<th>Side effects</th>
<th>Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Felbamate (dog)</td>
<td>20-30mg/kg BID-TID</td>
<td>20-30 h</td>
<td>35mg/l</td>
<td>Mainly urine, partial</td>
<td>Mild leukocyto-, Hematology, liver enzymes</td>
<td></td>
</tr>
<tr>
<td>Gabapentin (dog)</td>
<td>10mg/kg TID</td>
<td>&lt; 24 h</td>
<td>unknown</td>
<td>kidney, partial</td>
<td>Sedation,</td>
<td>no known organotoxicity</td>
</tr>
<tr>
<td>Pregabalin (dog)</td>
<td>3-4 mg/kg TID</td>
<td>&lt; 24 h</td>
<td>2-8 µg/mL</td>
<td>Mainly urine</td>
<td>Mild sedation, Ataxia</td>
<td>No known organotoxicity</td>
</tr>
<tr>
<td>Zonisamid/Zonegran (dog)</td>
<td>10mg/kg BID</td>
<td>&lt; 24 h</td>
<td>10-40 µg/mL</td>
<td>80% urine, milde sedation,</td>
<td>Possible hepatotoxic-</td>
<td></td>
</tr>
<tr>
<td>Levetiracetam/Keppra (dog and cat)</td>
<td>20 mg/kg TID (Hund) 20mg/kg TID (Katze)</td>
<td>unknown</td>
<td>80% urine</td>
<td>dog: Mild sedation, vomiting cat: transient lethargy, inappetence</td>
<td>No known organotoxicity</td>
<td></td>
</tr>
</tbody>
</table>
Cervical intervertebral disc disease (IVDD) accounts for 15% of all intervertebral disc problems in dogs. Two forms of disc disease that may require surgical management have been identified: Hansen Type I (extrusion of the nucleus pulposus) and Hansen Type II (continued degeneration and protrusion of the outer fibrous layers of the annulus). Several spinal decompression techniques have been described and evaluated for the cervical spine, including ventral slot decompression with and without subsequent stabilization and dorsal decompressive laminectomy. Although these procedures are effective, they can be associated with various complications, including hemorrhage from the vertebral plexus, residual material within an intervertebral foramen, luxation and instability at the surgical site for the ventral slot, the extent of muscle dissection required during the approach, and difficulties addressing ventral and ventrolateral disc material during dorsal decompression. Potential benefits of cervical hemilaminectomy include good visualization of the lateral spinal cord, nerve roots, and spinal canal, which facilitates removal of disc material in these areas because it does not remove large portions of either the intervertebral disc or vertebral body. Further, hemilaminectomy may avoid destabilization of the operated segment.

To date, the use of hemilaminectomy in the cervical spine has been described mainly for lateralized disc herniations, laterally located masses such as neoplasms or synovial cysts, or for lesions at the seventh cervical vertebra (C7) to the first thoracic vertebra (T1). There is only limited information in the literature regarding access to disc material located ventrolaterally and ventrally to the spinal cord by hemilaminectomy.

For the surgical procedure, the animals are positioned in sternal recumbency and rotated away from the surgeon at an approximate angle of 45° to ease visualization of the articular processes and vertebral pedicle. The skin was incised 1–2 cm lateral to the midline at the approximate location of the lesion over a length of three vertebral segments. The underlying platysma muscle was incised to expose either the brachiocephalicus muscle in the cranial cervical spine or the trapezius muscle in the caudal cervical spine. For lesions located in the cranial cervical spine, the brachiocephalicus muscle was incised parallel to its fibers to expose the underlying splenius and serratus ventralis muscles. Blunt division and retraction of these muscles revealed the underlying longissimus capitis and cervicis muscles. For lesions in the caudal cervical segments, the brachiocephalicus and trapezius muscles were separated and spread in a craniolateral and caudoventral direction to expose the splenius and serratus ventralis muscles. The scapula was abducted and caudally retracted to allow access to the C7–T1 segment. Identification of the affected segment was achieved by palpation of prominent anatomic land marks, including the wings of the atlas. The transverse process of C6, the first rib, and/or the dorsal spinoval processes of T1 and C7. From these points, the desired articular facets were palpated by counting the articular facets in either a caudal or rostral direction. Tendinous attachments of multifidus and complexus muscles of the desired articular process were incised using sharp dissection. After identification of the articular space between cranial and caudal facets, the joint capsule was incised. Large portions of the facets were removed with rongeurs, and a high speed air drill was used to create the hemilaminectomy/facetectomy. After drilling, the hemilaminectomy was completed with small rongeurs for fine bone removal. The nerve root, spinal ganglion, and lateral aspect of the spinal cord were visualized. Ventrally located disc material was removed with a blunt nerve root retractor or dental scraper (Hansen Type I). In one case with a Hansen type II disc protrusion, the dorsal annulus was incised with a scalpel no. 11 and annular fibers were excised with fine rongeurs until the spinal nerve/spinal cord returned to the floor of the spinal canal. If present, hemorrhage during removal of disc material was controlled with a macerated piece of muscle or absorbing hemostatic material. After the decompression was complete, the wound was flushed with sterile saline, and the muscles were apposed with simple interrupted sutures. The fascial layer was repaired using absorbable sutures in a simple interrupted pattern. The subcutaneous tissue and skin were closed in layers.

Postoperative care consists of administration of either parenteral opioid analgesics or nonsteroidal anti-inflammatory drugs. Strict cage rest, avoidance of stairs, and the use of cervical collars or harnesses for at least 4 wk.

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were recommended. Management of nonambulatory patients included nursing care and physical therapy (passive range of motion, supported gait exercises).

In our study, treatment was effective in 88% of dogs. Five large breed dogs (12%) did not improve. In dogs with a Hansen Type I disc extrusion, clinical signs improved in 96% of the cases. In dogs with a Hansen Type II disc protrusion, an excellent and good outcome was seen in 47% and 32% of cases, respectively. Outcome was significantly better for small breed dogs and dogs with Hansen Type I disc disease compared with large breed dogs and dogs with Hansen Type II disc disease.

Success rates and hospitalization times are similar to other decompressive procedures used to treat cervical disc disease. Success rates are significantly lower for large breed dogs with Hansen Type II disc lesions compared with small breed dogs with Hansen Type I disc lesions. Complications are similar to other procedures with the exception of iatrogenic destabilization, that has not been observed in this and other reports using cervical hemilaminectomy. If the surgeon is familiar with the surgical technique, cervical hemilaminectomy represents an expansion of the neurosurgical repertoire in the treatment of IVDD and can be considered an appropriate method of treatment with outcomes comparable to other decompressive techniques.

References: