Degenerative lumbosacral stenosis – a critical approach to different surgical techniques

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Due to the complex and yet unresolved pathophysiology of DLSS there is unlikely a single best answer to therapy. Consequently, a variety of therapies have been suggested but choice among these treatments frequently depends on the surgeon’s personal experience rather than on evidence-based criteria.

Non-surgical treatment

Both non-steroidal and steroidal antinflammatory drugs have been used in the medical treatment of dogs with DLSS. Rest or restricted activity is recommended as well as weight loss in obese dogs. There is scant evidence about the success of this treatment. One study reports a good outcome in 8 of 16 dogs treated conservatively within an observation period of 14 weeks while the other 8 animals did not respond to therapy (Denny et al., 1982). Six working GSD’s with minor degrees of DLSS were reported to respond satisfactorily to conservative management over a period of 3 years (Steffen et al., 2007). Epidural injection of methylprednisolon acetat into the lumbosacral epidural space in 38 affected dogs resulted in improvement (79%) and cure (53%) in most dogs (Janssens et al. 2009).

So far, there is no study that has evaluated the effects of physiotherapeutic exercises in dogs with DLSS.

In the author’s experience, a majority of cases with DLSS are likely to have clinical signs recur following episodes of increased activity. In contrast, the success of surgical therapy to treat DLSS is better documented but still far away from the proof that it is more effective.

Surgical treatment

Cases which do not respond to medical treatment and those with neurological deficits are best treated by means of surgery. The initial goal of the surgical procedure is to decompress the nerve roots of the cauda equina. Other authors advocate additional distracting and stabilizing procedures of the lumbosacral articulation in order to halt degenerative alterations and to optimize long term surgical success. As a consequence of these different opinions, a variety of
surgical techniques have been described but there is still a lack of comparative studies that would provide the evidence necessary to make the best surgical recommendations for the individual patient.

**Decompressive techniques**

Dorsal laminectomy is the most widely used surgical technique to decompress the cauda equina. Some authors describe removal of at least half of the roof of L7 and most of the sacrum (Danielsson and Sjöström, 1999), while others have performed only a limited laminectomy of S1 and removal of the ligamentum flavum with similar clinical results (Kinzel et al., 2004). The articular facets are preserved if possible, as they are important for maintenance of rotational stability (Sharp, 2005). After retraction of the cauda equina nerve roots the lumbosacral canal can be inspected for presence of compressive lesions. Bony and/or ligamentous proliferations may subsequently removed by excision (Chambers et al, 1988). The most common finding in DLSS is a protruded (Hansen Typ II) intervertebral disk and, therefore, partial discectomy (dorsal annulectomy, nuclear curettage) is oftentimes combined with dorsal laminectomy. The rationale behind partial discectomy is to release ventral compression and/or kinking of the cauda equina nerve roots. Experimental work in dogs demonstrates some potential risks of this technique. McMarron et al (Spine, 1987) have induced inflammation of nerve by placing autogenous nucleus pulposus in the epidural space of dogs. Similarly, incision of the annulus fibrosus has induced morphological, functional and histological changes in nerve roots of a dog model (Kayama et al., 1996). Despite these potential complications, importance of these findings in clinical cases is not known. A clinical study comparing dogs with dorsal laminectomy alone to those with concurrent partial discectomy did not reveal any differences between the outcomes of the two groups (Janssens et al., 2000). Success rates after dorsal laminectomy have been reported not to vary widely between several studies with exception of one investigation in military working dogs by Linn et al. (2003) were outcome was clearly less favourable (Table 1).

**Table 1. Success rate in dogs with DLSS treated with dorsal decompression and/or partial discectomy**

<table>
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<th>outcome</th>
<th>Number of dogs</th>
<th>Follow-up</th>
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<td>79 (normal function)</td>
<td>131</td>
<td>26 months +/- 17</td>
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While compressive lesions of the cauda equina within the lumbosacral canal (central and lateral stenosis) can be adequately addressed by dorsal decompressive techniques, compressive radiculopathy of the seventh lumbar nerve root (foraminal stenosis) requires a different approach. Unrecognized or untreated foraminal stenosis is an important cause of persisting postsurgical pain and “failed back surgery syndrome” in humans and needs to be specifically addressed to achieve good surgical outcomes (Fritsch et al., 1996; Maher et al., 1999). Several surgical methods have been described to approach compressions within the lumbosacral foramen. Total facetectomy has been described to successfully decompress the 7th lumbar nerve root in 15/15 dogs treated by this method; however, many patients in this study were of small breed which are likely to tolerate destabilisation of their spine (Tarvin and Prata, 1980). A total of 9/11 larger breeds that were treated with facetectomy have been reported to improve but were often left with recurring or persisting signs (Denny et al, 1982; Watt, 1991; Ness 1994). Nowadays, total facetectomy is no longer recommended because of its potential to destabilize the lumbosacral articulation (Sharp, 2005; Chambers 1997). Alternatively, a laterally directed fenestration of the intervertebral disk from a dorsal approach and medial foraminotomy has been described by several authors (Danielsson and Sjöström, 1999; Sharp, 2005; Chambers et al., 1997). Interestingly, while seemingly the solution for decreasing the incidence of destabilization of the spine when the technique was performed in 12 dogs, there was no difference in outcome compared to 15 dogs in which laminectomy alone was performed (de Risio, 2001). Other disadvantages of this technique include the inability to reach lateral lesions within the middle and exit zone of the foramen and the observation that the majority of lesions in the peripheral foraminal zones are osteophytes and
soft tissues proliferations further questioning the therapeutic value of removing disc tissue. Therefore, we have developed a new decompressive technique that enabled us to reach middle and exit zones of the foramen from a lateral direction (Gödde and Steffen, 2007). This approach was used as a stand alone technique or in combination with dorsal decompression and the outcome was good to excellent in 19/20 cases over a mean follow-up period of 15 months. We have concluded, that lateral foraminotomy represents an important expansion of the neurosurgical repertoire for decompressive techniques in the lumbosacral articulation (fig. 5).

Fig. 5. Dorsolateral lumbosacral foraminotomy in a dog with unilateral compression of the 7th lumbar nerve root, intraoperative photograph. The foraminotomy has been started at the level of the transverse process of L7 (T) and was then continued in a caudal direction.

Reported recurrence rates in dogs that were treated with decompressive techniques vary widely with highly active working dogs having the greatest risk for recurrence of clinical signs (Linn et al., 2003). One likely explanation for this observation is that working dogs stress an operated lumbosacral joint beyond its limits. Other explanations include progression of the degeneration, altered (i.e. painful) mobility of the operated LS junction or incomplete decompression of nerve roots (i.e. failed back-surgery syndrome).

Stabilizing techniques
Similar to the situation in human patients, the indications for instrumented stabilization in degenerative conditions of the lumbosacral spine are still not clear in dogs and choices are more or less based upon a surgeon’s beliefs and experiences. To date, some arguments and facts support the use of stabilizing procedures in addition to decompressive techniques:
Force plate analysis of dogs with DLSS showed that impaired propulsion of the pelvic limbs increased after decompressive surgery, but normal propulsion was not reached. Additional support of the lumbosacral joint may improve propulsive force (Van Klaveren et al., 2005). A recent report of the same group describes a “trend toward normal” propulsion in dogs treated with pedicle screw-rod fixation (Smolders et al, 2012),

Dynamic imaging studies of the lumbosacral articulation demonstrate not only a high mobility of the joint but also that the compression is worse in most dogs with DLSS when it is in extended position compared with a flexed position (Lang, 1988). Considering this fact it may be beneficial to limit or eliminate joint movements and, thus, to decrease the potential risk of persisting dynamic compression of the cauda equina.

Dorsal laminectomy and discectomy do not cause significant spinal instability in flexion and extension load force in normal cadaver lumbosacral specimens (Meji et al., 2007; Smith et al., 2004). However, cyclic flexion-extension loads after discectomy may increase range of motion (ROM), leading to spinal instability even if ROM does not increase immediately after surgery. Thus, degenerative changes may develop, which, after initial improvement, result in worsening caudal lumbar pain in the long term. (Kuroki et al., 2004; fig. 6).

The main concerns against stabilizing the lumbosacral joint include problems related to implant failure and the fact that a stabilized and fused spinal segment seems to shunt excessive stresses to adjacent segments producing a “domino-lesion” (also known as adjacent segment disease). However, this complication has not yet been reported in dogs with DLSS.

Fig. 6. MRI (T2W) of a 11 year-old GSD that had dorsal laminectomy 3 years previously and was now presented with a 4 week history of low back Bain, non-weight bearing lameness on the left pelvic limb and marked muscle atrophy of the myotomes of the left sciatic nerve.
The sagittal image (A) shows spondylosis deformans (SD), a disk protrusion with stenosis of the spinal canal, deviation of the cauda equina and a laminectomy membrane/fibrous scar tissue (LM) at the site of the previous surgery. The transverse image taken at the level of S1 (B) shows the laminectomy membrane and a synovial cyst arising from the right facet joint. The transverse image taken at the level of the lumbosacral intervertebral foramen (C) shows absence of the fat signal in all foraminal zones due to foraminal stenosis (FS) at the left (L).

Several stabilization techniques in dogs with DLSS have been reported, including cross pin fixation (Slocum and Devine, 1986), transarticular screw fixation combined with dorsal laminectomy (Bagley, 2003; Hankin et al. 2012; Golini et al. 2014), fixation and fusion using pedicle screws fixed with a bone cement bridge (Sharp, 2005) and pedicle screw-rod fixation (Méheust, 2000; Meij et al., 2007; Smolders et al., 2012).

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A
B
C
D

Fig. 7. Postoperative ventrodorsal radiographs of three German Shepherd Dogs treated with different techniques of lumbosacral stabilization
A) transarticular screws through the lumbosacral facet joints (Bagley, 2003). B) Bilateral pedicle screw fixed with bone cement bridges (Sharp, 2005) and C) Unilateral pedicle screw and bone cement fixation combined with transarticular screws through both lumbosacral facet joints. (Kyung et al., 2000). D) Pedicle screw-rod fixation with corporal placement of the implants in L7. Additional rigidity was achieved with transarticular screws (Smolders et al, 2012). One year postoperatively, all dogs ambulated normally and were pain-free.

Considering that the center of rotation at the lumbosacral articulation is located near the endplate of L7 and the disk stabilizing procedures at the level of the facet joint seem to provide potentially less stability than procedures that stabilize the joint at the level of the vertebral bodies. A clinical study about 26 dogs treated with transarticular fixation reported improvement in all cases, with 85% being completely normal at 6 months. In a recent study, these results were not mirrored as only 75% of dogs treated with this procedure improved and 25% needed revision surgery or continuous medication with NSAIDs. Imaging follow-up
using dynamic CT scans revealed that this technique does not result in rigid stabilisation of the LS joint which may explain the considerably high rate of implant failure (30%) after 12 months (Golini et al., 2014). A cadaveric study using pedicle screw-rod fixation found that this technique effectively stabilizes the lumbosacral spine (Meij et al., 2007). However, it is not clear if complete stabilization is superior over partial stabilization of the lumbosacral joint. This is illustrated by a comparison of the available clinical data. All dogs in one study using facet joint stabilization (n=8) and all dogs in a study using pedicle-screws and rods (n=5) were reported to have good long-term outcome (Slocum, 1986; Méheust, 2000). In another report, treatment of 9 military working dogs using pedicle-screws and rods was initially successful in 8/9 animals, but later on 4/9 had recurrence of pain at the lumbosacral spine that precluded further duty. (Carpenter et al., 2006). Similar results are reported in a study of 3 clinically affected dogs treated with pedicle-screws and rods (Smolders et al., 2012). This limited number of case studies is not valid to allow definitive statements about the success rate of each method but it indicates that the golden bullet for treating DLSS, especially in dogs with high physical performance, does not yet exist. Controlled, randomized studies that compare outcomes in dogs that have been treated with stabilizing techniques and decompression alone have not been published. In humans, one study reported better results after fusion procedures than after decompression alone (Fox et al., 1996). Conversely, a large meta-analysis of all available data in people found that fusion did not improve outcome and was associated with a higher complication rate (Gibson et al., 2002).

Due to lack of evidence-based studies in veterinary lumbosacral surgery it is not possible to determine the benefit and risks of decompressive versus stabilizing procedures at present. Therefore, how best to treat DLSS surgically is debatable and the technique of choice for the various degrees of severity of DLSS remains to be established.

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