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Objective—To identify predictive factors of long-term outcome after dorsal decompressive laminectomy for the treatment of degenerative lumbosacral stenosis (DLSS) in dogs.

Design—Retrospective study.

Sample Population—69 client-owned dogs.

Procedure—Medical records of dogs that had undergone dorsal laminectomy at North Carolina State University and the University of Tennessee between 1987 and 1997 were reviewed. Dogs with diskospondylitis, traumatic lesions, or neoplasia of the lumbosacral region were excluded. All dogs had evidence of cauda equina compression on myelography, epidurography, computed tomography, or magnetic resonance imaging, along with subsequent confirmation of the lesion at surgery. Follow-up was performed by telephone inquiries to the referring veterinarian, the owner, or both, using a detailed questionnaire.

Results—The outcome was excellent or good in 54 of 69 (78%) dogs over a mean follow-up period of 38 ± 22 months. Five of these 54 dogs had been incontinent for a median of 2 weeks prior to surgery. Six of the 15 dogs with a poor outcome had been incontinent for a median of 8 weeks before surgery. A significant correlation was detected between the presence of urinary or fecal incontinence prior to surgery and outcome. When duration of signs was considered, urinary incontinence was the only variable that significantly affected outcome.

Conclusions and Clinical Relevance— Decompressive laminectomy is an effective treatment for DLSS, although dogs with urinary or fecal incontinence have a worse prognosis than dogs that are continent before surgery. Chronic urinary incontinence is a predictor of poor outcome for dogs with DLSS. (J Am Vet Med Assoc 2001;219:624–628)

Degenerative lumbosacral stenosis (DLSS) is an acquired narrowing of the vertebral canal, intervertebral foraminae, or both, which results in compressive radiculopathy of the cauda equina. Stenosis is caused by varying combinations of Hansen type-II disk protrusion, hypertrophied soft tissue (ligamentous and synovial structures), vertebral diarthrodial joint osteophytes, lumbosacral spondylosis, and instability. Predisposition to DLSS may be caused by congenital or developmental vertebral anomalies. If a dog is born with a relatively narrow vertebral canal, minimal degenerative changes may be sufficient to cause clinical signs. Vertebral malformations such as transitional vertebrae may initiate DLSS by altering spinal biomechanics. Degenerative lumbosacral stenosis affects middle-aged medium to large breeds, particularly German Shepherd Dogs. The male to female ratio is close to 2:1 in most reports. The most common clinical finding is lumbosacral pain. Neurologic deficits, when present, are lower motor neuron in nature and are consistent with changes in motor and sensory function of the pelvic limbs, tail, perineal region, and urinary or fecal incontinence. These clinical signs may occur alone or in any combination and depend on which nerve roots are involved and the nature of the compromise. Several diagnostic procedures have been used to confirm a clinical suspicion of DLSS, and their advantages and disadvantages have been reviewed. Conservative management has been recommended when pain is the only clinical sign. Surgical treatment is indicated when signs of pain are not alleviated by conservative management or when there are motor or sensory deficits. The 2 basic surgical techniques are decompression by dorsal laminectomy (with discectomy, foraminal decompression, or both) and distraction-fusion. The purpose of the study reported here was to identify factors that may be used to predict long-term outcome after decompressive laminectomy for DLSS.

Criteria for Selection of Cases

Medical records of dogs that had undergone dorsal decompressive surgery for DLSS at the Veterinary Teaching Hospital (VTH) of North Carolina State University (NCSU) and the University of Tennessee (UT) between April 1987 and May 1997 were reviewed. Entry criteria were modified slightly from those reported by Danielsson and Sjostrom. For inclusion in our study, dogs had to have evidence of lumbosacral compression on myelography, epidurography, computed tomography (CT), or magnetic resonance imaging (MRI), along with subsequent confirmation of the lesion at surgery. A minimum follow-up...
period of 6 months after surgery was required for each dog. Dogs with primary orthopedic disease or with dis- cospondylitis, traumatic, or neoplastic lumbosacral lesions were excluded from the study.

**Procedures**

General physical, neurologic, and orthopedic examinations were performed in all dogs. A CBC, serum biochemical analysis, urinalysis, and CSF analysis were performed for each dog. The CSF was collected from the cerebellomedullary cistern in all dogs, and most dogs also had a lumbar puncture performed (between L3 and L6 or L4 and L5). Diagnostic imaging of the lumbosacral region included survey radiography, epidurography, discography, myelography, CT, or MRI. Dynamic imaging (with the lumbosacral joint flexed and extended) was performed in most myelographic and epidurographic studies. The positive contrast agent used in all radiographic contrast procedures was iohexol. Computed tomography was performed, using a third generation scanner. Contiguous 3-mm slices were obtained parallel to the L7 end plate from the cranial aspect of L6 to mid-S3. Additional 1-mm contiguous slices were obtained over the lumbosacral joint. Sagittal and dorsal plane reformatted images were obtained at the L7-S1 intervertebral disk space and foraminal. Magnetic resonance imaging was performed using a 0.5 Tesla superconducting scanner. T1-weighted transaxial images were acquired, and T1-weighted, T2-weighted, and proton density sagittal images were made. Slice thickness of transaxial images was 3 mm. Electromyography (EMG) of tail, pelvic diaphragm, pelvic limb, and anal sphincter muscles was performed, using standard techniques. All diagnostic procedures were performed with the dog under general anesthesia. Each dog then underwent dorsal laminectomy. Additional procedures were performed when indicated by either imaging studies or by palpation at surgery. These included discectomy for an upward bulge of the lumbosacral disk or exposure of the lateral recess and intervertebral foramen for foraminal stenosis. Facetectomy was not performed. Short-term follow-up examinations were performed at the NCSU-VTH or at the UT-VTH at 4 to 6 weeks after surgery in most instances. Long-term follow-up was carried out by telephone inquiries to either the referring veterinarian, the owner, or both, using a detailed questionnaire. Several dogs were also reevaluated at the VTH at least 6 months after the lumbosacral surgery. The outcome was defined as excellent if there was a complete resolution of clinical signs and good if there was a substantial improvement in all clinical signs. Improvement was considered substantial when all preoperative signs were resolved, but the dog still had occasional mild signs of lumbosacral pain or pelvic limb weakness, especially after prolonged exercise. The outcome was defined as poor if 1 or more of the preoperative clinical signs did not resolve and if there were neurologic deficits other than intermittent weakness. Dogs that had a good or excellent outcome for at least 6 months after surgery and that subsequently developed 1 or more signs of lumbosacral disease were considered to have suffered a recurrence.

**Statistical analyses**—Statistical analysis of our data was performed to examine the correlation between presence and duration of individual clinical signs prior to surgery and outcome, assess the effect of discectomy or foraminal decompression on outcome, and determine the effect of follow-up method on outcome. The χ² test was used to assess the effect of discectomy or foraminal decompression on outcome. This test was also used to assess whether there was a correlation between the presence of determinate clinical signs prior to surgery and outcome. Preoperative signs included in this analysis were lumbosacral pain, pelvic limb lameness, pelvic limb weakness, tail paralysis, urinary incontinence, and fecal incontinence. Significance was set at P < 0.05. The influence on the outcome of certain neurologic deficits such as reduced withdrawal reflex, patellar pseudohyperreflexia, and decreased perineal reflex could not be assessed, because in most cases follow-up was performed only by telephone. In addition to assessing the relationship between the presence of individual signs and outcome, we also used an ordinal logistic regression model (α = 0.02) to examine the effect of duration of each of the aforementioned preoperative signs and outcome (ie, excellent, good, or poor). Binomial tests, using large sample approximations, were used to determine whether dogs with signs persisting > 6 months were more likely to have a poor outcome and to assess the effect of the follow-up method (by veterinarian or by owner) on outcome.

**Results**

Sixty-nine dogs met the inclusion criteria; ages ranged from 2 to 13 years (mean ± SD; 6.75 ± 2.8 years). There were 50 male dogs (29 were castrated) and 19 females (16 were spayed). The male to female ratio was 2.6:1. Twelve dogs were of mixed breed, and 57 were purebred. The German Shepherd Dog was the most common breed, accounting for 19 of 69 (27%) cases, followed by the Golden Retriever (7/69; 10%) and the Labrador Retriever (7/69; 10%). Most dogs were > 25 kg (> 55 lb) in body weight. Only 5 were working dogs or very active dogs (such as hunting dogs). A dog was considered very active when it was involved in heavy exercise (running, jumping, climbing) for 4 or more hours a day.

Clinical signs included signs of pain in the lower lumbar region in 53 of 69 (77%) dogs, pelvic limb weakness in 37 of 69 (53 %), pelvic limb lameness in 26 of 69 (38%), tail paralysis in 11 of 69 (16%), urinary incontinence in 10 of 69 (14%), fecal incontinence in 4 of 69 (6%), both urinary and fecal incontinence in 3 of 69 (4.5%), and tail chewing in 2 of 69 (3%). Pelvic limb weakness was manifested as difficulty jumping, climbing, rising, or sitting. Pelvic limb lameness was unilateral in 20 dogs and bilateral in 6. Duration of clinical signs ranged from 1 week to 2 years, with a mean ± SD of 3.3 ± 4.3 months. On neurologic examination, the most common clinical finding was pain on palpation or hyperextension of the lumbosacral junc- tion; this was detected in 63 of 69 (91%) dogs. Lumbosacral hyperaesthesia could be differentiated from pain associated with hip dysplasia by transrectal palpation of the lumbosacral joint and by applying dig-
itral pressure on the spinous processes of L7 and S1 with the dog standing. This latter maneuver was also associated with concurrent extension of the tail. Pelvic limb conscious proprioceptive deficits were found in 27 of 69 (39%) dogs. A reduced withdrawal reflex, manifesting as decreased hock flexion with normal hip and stifle flexion, was recorded in 13 (19%) dogs. Ten (14%) dogs had patellar pseudo-hyperreflexia, and 5 (7%) had a decreased perineal reflex.

Results of CBC, serum biochemical analysis, and urinalysis were within reference ranges in all dogs. Results of CSF analysis ruled out infectious or inflammatory diseases in all dogs. In a few cases, the only abnormality was a mild increase in protein of the lumbar CSF, consistent with extradural compression of the nervous tissue.

The most common finding on survey radiography was lumbosacral spondylosis (71% of dogs). Ventral subluxation of the sacrum in relation to L7 was evident in only 6 (9%) dogs. Transitional vertebrae were seen in 5 (7%) dogs (3 German Shepherd Dogs, 1 mixed-breed, and 1 Pointer). Abnormalities of the lumbosacral region were not detected radiographically in 11 (16%) dogs. In 1 dog, the only abnormality that was detected radiographically was a narrowed vertebral canal from the cranial aspect of L7 to the cranial aspect of S1. Myelography was performed in 36 dogs, and cauda equina compression was evident in 27 (75%). The dural sac extended over the L-S junction in 30 (83%) of 36 dogs that underwent myelography. Of these 30 dogs, 90% had demonstrable pathologic lesions on myographic exam. Of the 9 dogs in which the myelogram was not helpful in the diagnosis of DLSS, 6 had a dural sac that did not extend over the L-S joint, and the compression (mainly Hansen type-II disk protrusion) was evident on epidurography. The other 3 dogs had a normal myelogram; however, lesions could be identified on MRI in 1 (this dog also had a normal epidurogram) and on CT in 2. In these 3 dogs, the compressive lesion was mainly localized within the intervertebral foramen and lateral recesses. Epidurography was performed in 40 dogs; compression was evident in all but 1 dog (98%). Discography was performed in 14 dogs and was abnormal in all but 1 dog (93%). This dog also had a normal myelogram; the lesion was finally diagnosed by use of epidurography, which revealed a dorsal compression at the lumbosacral junction. Computed tomography was performed in 13 dogs and MRI in 21. The CT and MRI were diagnostic in all cases, and these techniques also helped to lateralize the lesion. Thirty dogs underwent 2 imaging procedures, and 6 dogs underwent 3 or more. The choice of imaging procedures was based on the diagnostic requirements of each dog, the personal preferences of the clinician, and on the availability of CT and MRI.

Electromyography was performed on 22 dogs, and abnormalities were found in 19 (86%). The most common findings were fibrillation potentials or positive sharp waves in the tail, pelvic diaphragm, or anal sphincter muscles and, to a lesser extent, in the pelvic limb musculature. Of the 3 dogs with a normal EMG, I had only lumbarosacal pain, I had lumbarosacal pain and unilateral pelvic limb lameness for 1 week, and the other had intermittent lumbarosacal pain as well as pelvic limb weakness and mild conscious proprioceptive deficits for a few days.

Dorsal decompressive laminectomy was performed in all 69 dogs; in the 54 dogs that had annular hypertrophy, it was combined with discectomy. Extrusion of mineralized disk material in the vertebral canal at L7-S1 was found only in 1 dog. Foraminal decompression (foraminotomy) was performed in 12 dogs, 10 unilateral and 2 bilateral. In all cases, the owner was instructed to confine the dog for 3 to 4 weeks after surgery and to then increase the activity level gradually over the following 2 months. The follow-up period after staged surgery ranged from 6 to 96 months, with a mean of 38 ± 22 months and a median of 36 months. Twenty-five dogs were reevaluated at their respective VTH, with follow-up intervals ranging from 6 to 39 months (mean, 22 months). Twenty-nine dogs were reexamined by the referring veterinarian who responded to our telephone inquiry. The follow-up intervals for these dogs ranged from 10 to 96 months (mean, 53 months). In 65 cases, the owner was contacted and answered a detailed questionnaire. The follow-up intervals for these dogs ranged from 6 to 96 months (mean, 39 months). In 25 cases, the questionnaire was answered by the owner and the referring veterinarian. Twenty-two dogs were still alive at the time of this study. Of the 47 dogs that died, 2 were euthanatized because of lack of improvement after lumbosacral surgery. All other dogs died or were euthanatized for unrelated causes.

In 26 of 69 (38%) dogs, the outcome was excellent with a complete resolution of clinical signs. In 28 of 69 (40%) dogs, the result was considered good with a substantial improvement in all clinical signs. In 13 of 69 (22%) dogs, the outcome was considered poor because of persistence of preoperative clinical signs. Overall, 78% of dogs had an excellent or good outcome. Excellent or good outcomes were recorded in 40 of 54 (80%) dogs that were followed-up by owner assessment and in 52 of 65 (74%) dogs followed-up by assessment of the veterinarian. These outcomes did not differ significantly from the overall outcome (P = 0.39 and 0.71, respectively). Only 5 dogs in our study were very active or working dogs; 4 of these had an excellent or good outcome. The preoperative signs of dysfunction in these 4 working dogs with a successful outcome ranged from a decreased level of exercise and lumbosacral pain to hind limb conscious proprioceptive deficits and urinary incontinence (only in 1 dog). The 1 working dog with a poor outcome had mild neurologic dysfunction consistent with a decreased level of activity and lumbosacral pain of 3 months’ duration before surgery. Four of 10 (40%) dogs in which clinical signs had been present for > 6 months had a poor outcome, which did not differ significantly from the 15 of 69 dogs (22%) that had a poor outcome overall (P = 0.162). Dogs in which laminectomy plus discectomy was performed (54 dogs) did not have a significantly better outcome (P = 0.287) than dogs in which laminectomy alone was performed (15 dogs). Dogs in which laminectomy plus foraminal decompression was performed (12 dogs) did not have a significantly better outcome (P = 0.085) than dogs in which laminectomy alone was performed (15 dogs).

Eleven dogs had urinary or fecal incontinence (7 urinary, 1 fecal, 3 urinary and fecal) prior to decom-
pressive surgery. Five of these dogs did not have incontinence after surgery. These 5 dogs had been incontinent (4 urinary, 1 urinary and fecal) for 0.5 to 1.5 months prior to surgery, with a median of 0.5 months. The other 6 incontinent dogs had a poor outcome. These 6 dogs had been incontinent (3 urinary, 1 fecal, and 2 urinary and fecal) for 1 to 18 months prior to surgery, with a median of 2 months. The only preoperative clinical signs that had a significant correlation with outcome were urinary (P = 0.012) and fecal (P = 0.014) incontinence. When an ordinal logistic regression model was used to assess the effect of the duration of each preoperative clinical sign on outcome, only duration of urinary incontinence significantly (P = 0.02) affected outcome. The probability of a poor outcome model was used to assess the effect of the duration

Discussion

The signalment, history, and clinical signs of the dogs in our study were similar to those reported previously. The mean age was approximately 7 years, with male dogs and German Shepherd Dogs being overrepresented. The most common historical findings were pain in the caudal lumbar region and pelvic limb weakness manifested as a reluctance or difficulty in jumping, climbing, rising, or sitting. The frequency of pelvic limb weakness may have been overestimated as these clinical signs could also have resulted from pain in the lumbar region. Neurologic deficits relate either to the sciatic nerve (conscious proprioceptive deficits, decreased hock flexion, or patellar pseudo-hyperreflexia) or to the pelvic, pudendal, or caudal nerves (urinary or fecal incontinence, motor or sensory deficits to the perineum or tail). The variety of procedures performed in our study is typical for the diagnosis of DLSS. The most sensitive diagnostic techniques were MRI and CT, followed closely by epidurography and EMG. Electromyography is useful as it often provides complimentary information to that obtained by clinical evaluation and imaging studies. Myelography was commonly performed, because it allows the clinician to identify spinal cord lesions (particularly within the caudal lumbar and sacral spinal cord segments) such as Hansen type-II disk protrusions and neoplasia that may contribute to the clinical signs. Myelography and epidurography also allow for dynamic studies to be performed more readily than do CT or MRI.

Detailed information on the long-term outcome of dorsal laminectomy for DLSS is limited and the results have varied. Two of the studies reported proportions of dogs with excellent or good outcomes similar to those found in our study (77 and 73% after mean follow-up periods of 14 and 21 months, respectively). However, our results were less favorable than those of 2 other studies, it was reported that 93% and 94% of dogs improved after mean follow-up periods of 26 and 19 months, respectively. However, of the 18 dogs in the study in which a 94% improvement was reported, 7 dogs improved but still had neurologic deficits, and 1 did not improve. Therefore, only 10 of these 18 (56%) dogs would have had an excellent or good outcome according to our criteria. The report citing a 93% improvement is a detailed study of 131 dogs. We actually modeled our inclusion criteria on this study on 131 dogs to facilitate comparison between the results of the two studies. Dogs with traumatic, infectious, or neoplastic conditions of the lumbosacral region were excluded along with dogs that had major orthopedic disease.

There are obvious limitations in trying to interpret data obtained retrospectively. A true control population of untreated animals is difficult to obtain, as most owners want surgical intervention once diagnostic testing has been performed. In addition, 1 of our criteria for diagnosis was that the lesion be confirmed at surgery. Another drawback of our study was that different board-certified individuals performed the various diagnostic and surgical interventions at 2 institutions. Finally, our follow-up was performed primarily by telephone. This was necessary because most of the dogs (47/69; 68%) had died by the time of our study. We did, however, determine that there was no significant difference between the results of dogs followed-up by a veterinarian’s assessment (52/65 dogs; 74%), compared with those followed-up by an owner’s assessment (40/54; 80%).

Statistical analysis of our data revealed that presence of urinary or fecal incontinence prior to surgery were the only individual clinical signs that significantly affected outcome. Furthermore, the preoperative duration of urinary incontinence (but not the duration of fecal incontinence) was the only temporal variable that had a significant influence on outcome. There are 2 studies in which long-term follow-up after dorsal laminectomy for DLSS is reported in which specific data on the outcome of incontinence is included. In
these studies, approximately one third of the dogs had urinary incontinence, which only resolved after surgery in 1 of 8 (13%) dogs and 1 of 5 (20%) dogs, respectively.6-11 In 1 of these studies,11 86% of the dogs that were incontinent had a poor outcome. In our study, 6 of 11 (55%) dogs that were incontinent had a poor outcome. We conclude that fecal incontinence as well as the presence and duration of urinary incontinence prior to surgery is a useful prognostic factor in dogs with DLSS.

Only 2 of 69 (3%) dogs had a recurrence of signs 6 months or more after surgery. Postoperative recurrences were also reported in another study,12 however, a much higher proportion (23/131; 18%) of dogs had recurrence of clinical signs than in our study. It is possible that the higher recurrence rate was attributable to the fact that 76 of the 131 animals were working dogs, and 59 (78%) of these continued to be very active after surgery. Most of the dogs in our study were not highly active before or after surgery, but 2 dogs did undergo a second surgery. One dog with a poor outcome underwent a second dorsal laminectomy and then had a good long-term result. One dog had a recurrence of signs 36 months after the first surgery and underwent a second dorsal laminectomy, which resulted in an excellent long-term outcome. Another study12 also reported favorable results in dogs that underwent a second surgery. Three of 4 dogs in that study12 that underwent a second surgery because of relapse made a full recovery. Potential causes of recurrence include scar tissue formation within the vertebral canal, fracture of the facet joint, lumbosacral hypermobility, or newly formed osteophytes and soft tissue hypertrophy.11,12 Our results support the suggestion that a second operation is justified in dogs that either have a poor initial outcome or recurrence of signs following dorsal laminectomy for DLSS.11,12

Decompressive laminectomy is an effective treatment for DLSS in the majority of pet dogs. Dogs that are incontinent, particularly those with urinary incontinence of more than 1-month duration, have a guarded prognosis if treated by decompressive surgery.10,11

References