Comparison of decompressive surgery, electroacupuncture, and decompressive surgery followed by electroacupuncture for the treatment of dogs with intervertebral disk disease with long-standing severe neurologic deficits

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Objective—To compare the effects of decompressive surgery (DSX), electroacupuncture (EAP), and DSX followed by EAP (DSX + EAP) for the treatment of thoracolumbar intervertebral disk disease (IVDD) in dogs with severe neurologic deficits of > 48 hours' duration.

Design—Retrospective case series and prospective clinical trial.

Animals—40 dogs between 3 and 6 years old and weighing between 10 and 20 kg (22 and 44 lb) with long-standing (> 48 hours) clinical signs of severe neurologic disease attributable to thoracolumbar IVDD.

Procedures—Thoracolumbar medullar injury was classified on the basis of neurologic signs by use of a scale ranging from 1 (least severe) to 5 (most severe). The DSX dogs (n = 10) were retrospectively selected from those that underwent DSX for the treatment of thoracolumbar IVDD. In addition, 19 dogs received EAP alone and 11 dogs underwent DSX followed by EAP (DSX + EAP). Outcome was considered a clinical success when a dog initially classified as grade 4 or 5 was classified as grade 1 or 2 within 6 months after the end of treatment.

Results—The proportion of dogs with clinical success was significantly higher for dogs that underwent EAP (15/19) than for dogs that underwent DSX (4/10); the proportion of dogs with clinical success for dogs that underwent DSX + EAP was intermediate (8/11).

Conclusions and Clinical Relevance—EAP was more effective than DSX for recovery of ambulation and improvement in neurologic deficits in dogs with long-standing severe deficits attributable to thoracolumbar IVDD. (*J Am Vet Med Assoc* 2010;236:1225–1229)

Type I IVDD is a premature hardening of the nucleus pulposus of the vertebral disk associated with a weakness of the annulus fibrosus. There is rupture of the annulus fibrosus, and the nucleus pulposus extrudes against the spinal cord.[1] The pain and neurologic signs attributable to IVDD are probably related to both compression and inflammation of the spinal cord.[2]

Intervertebral disk disease affects most of the breeds of chondrodystrophic dogs, with the highest incidence in dogs between 3 and 6 years of age.[3] In these breeds, > 85% of the dogs with IVDD have involvement of the region from the T11-12 disk to the L2-3 disk and 50% have involvement of the region from the T12-13 disk to the T13-L1 disk. In large-breed dogs, the disease mainly affects the L1-2 disk.[4] Primary clinical signs are pain in the vertebral region, somatosensory and motor deficits of the pelvic limb, and genitourinary dysfunction. However, IVDD may affect various areas of the vertebral column, with a wide range of clinical signs.

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Abbreviations

CT	Computed tomography
DSX	Decompressive surgery
EAP	Electroacupuncture
IVDD	Intervertebral disk disease
MRI	Magnetic resonance imaging

Treatment options usually are based on clinical experience of the clinician, rather than being based on results of controlled scientific studies.[3,5] Recovery of neurologic function may be achieved with nonsurgical or surgical treatment. Nonsurgical treatment typically involves rest in a confined space and judicious use of analgesics and anti-inflammatory drugs. Surgical decompression is the principal mode of treatment for IVDD; however, precise diagnostic imaging equipment and a surgeon with the necessary expertise may not be available because of the necessity (in many cases) for emergency surgical intervention. It is highly recommended to perform surgical intervention as quickly as possible after the onset of the neurologic signs because the success rate is greatly reduced when surgery is delayed ≥ 48 hours after there is no deep pain perception.[6,7]

Acupuncture has been used for the treatment of IVDD in dogs.[8–10] It is indicated for pain relief and to

restore motor and somatosensory function and bladder control.[11–13] Few controlled studies[14,15] have been conducted to compare the efficacy of acupuncture with that of conservative treatment in dogs. To our knowledge, no studies have been conducted to compare the effect of acupuncture for dogs with IVDD with that of surgical treatment in this species.

Therefore, the objective of the study reported here was to compare the effect of DSX, EAP, and DSX + EAP for treatment of thoracolumbar IVDD in dogs with long-standing severe neurologic deficits. It was hypothesized that EAP would be more effective for improvements in neurologic function and recovery of ambulation in dogs, compared with results for surgery, when performed ≥ 48 hours after the onset of clinical signs of IVDD.

Materials and Methods

Animals—Forty dogs were included in the study. All dogs were between 3 and 6 years old, weighed between 10 and 20 kg (22 and 44 lb), and had long-standing (> 48 hours) severe neurologic disease attributable to thoracolumbar IVDD. The study was approved by the São Paulo State University Institutional Animal Research Ethics Committee. Informed consent of owners was obtained for use of their dogs.

Experimental groups—For the DSX group, 10 dogs were retrospectively selected from those dogs that underwent DSX for the treatment of thoracolumbar IVDD at our university veterinary medical hospital between 2003 and 2006. The other 2 groups comprised dogs evaluated by 2 veterinarians (SCR and SPLL) between 2006 and 2008; these dogs were then assigned, according to each owner's decision, to the EAP (n = 19) and DSX + EAP (11) groups. Dogs were classified via a modified myelopathy scoring system reported elsewhere.[13,16,17] Scores ranged from 1 to 5 on the basis of the degree of severity of neurologic signs, as follows: grade 1, pain in the vertebral region with no abnormal neurologic signs; grade 2, able to bear weight, deficits of proprioception, and ambulatory paraparesis; grade 3, unable to bear weight, severe incoordination, intact spinal reflexes or hyperreflexia, and deep pain perception; grade 4, nonambulatory paraparesis, deficits of proprioception, and deep pain perception; and grade 5, any of the aforementioned clinical signs plus paraplegia, no deep pain perception, and bladder dysfunction. All dogs were included in the study only when the diagnosis of IVDD was confirmed by use of myelography, MRI, or CT. In all dogs, the inclusion criteria were onset of neurologic signs ≥ 48 hours before therapeutic intervention and paraparesis (grade 4) or paralysis (grade 5).

Treatment—Dogs were initially treated by administration of prednisone (1 mg/kg [0.45 mg/lb], PO, q 24 h for 3 days; followed by 0.5 mg/kg [0.23 mg/lb], PO, q 24 h for 4 days). In dogs that underwent DSX < 7 days after onset of prednisone administration, treatment with prednisone was discontinued at the time of surgery. Interval from admission at our veterinary medical hospital until surgery ranged from 3 to 15 days (median, 8 days) for the DSX group and from 4 to 61 days (median, 14 days) for the DSX + EAP dogs. Surgery was often delayed because most of the dogs were referred from private practices located far from our veterinary medical hospital. Hemilaminectomy alone or hemilaminectomy and disk fenestration was performed in 7 and 3 dogs, respectively, of the DSX group, whereas hemilaminectomy and disk fenestration was performed in all 11 dogs of the DSX + EAP group.

For EAP, acupuncture points were selected on the basis of the location of the IVDD and in accordance with reported effects on the nervous and locomotor system and traditional Chinese theory regarding location of the points.[18] The following points were used: bladder 18, 23, and 40; kidney 3; gallbladder 30 and 34; and stomach 36.[19] The EAP stimulation was performed with the following pairs of acupuncture points on the same side of each dog: bladder 18 and 23 and stomach 36 and gallbladder 34. Alternating current electrostimulation was performed for 20 minutes at low frequencies of 2 and 15 Hz.[20] Voltage was increased until muscle twitching was observed. Treatment was performed (EAP alone or after DSX) once per week for 1 to 6 months. Treatment was discontinued when dogs were classified as grade 1 or 2 IVDD.

Clinical evaluation—Myelopathy scoring was performed before and after treatment (6 months after surgery for the DSX and DSX + EAP dogs and 6 months after initiation of acupuncture for the EAP dogs). Treatment was considered a clinical success when dogs (all of which had an initial grade of 4 or 5) improved to grade 1 or 2, were able to walk without assistance, and recovered deep pain perception by 6 months after the treatment was initiated.[1]

Statistical analysis—The myelopathy score obtained for each dog as well as the number of dogs with deep pain perception before and at 6 months after initiation of treatment were compared by use of the Goodman test for contrast among multinomial populations.[21,22] Values of $P < 0.05$ were considered significant.

Results

The groups were considered uniform on the basis of neurologic signs and myelopathy scores. For DSX dogs, location of IVDD was detected by use of myelography in 7 dogs and MRI in 3 dogs, and IVDD affected the region between the T11-12 and L2-3 disks in 9 dogs and the region between the T6-7 and T8-9 disks in 1 dog. There was 1 affected disk in 6 dogs, 2 affected disks in 2 dogs, and 3 affected disks in 2 dogs. For EAP dogs, location of IVDD was detected by use of myelography in 15 dogs, MRI in 3 dogs, and CT in 1 dog, and IVDD affected the region between the T11-12 and L2-3 disks in 16 dogs, the region between the T9-10 and T10-11 disks in 2 dogs, and the region between the T8-9 and T9-10 disks in 1 dog. There was 1 affected disk in 13 dogs and 2 affected disks in 6 dogs. For DSX + EAP dogs, location of IVDD was detected by use of myelography in 5 dogs, MRI in 5 dogs, and CT in 1 dog, and IVDD affected the region between the T11-12 and T13-L1 disks in 9 dogs and between the T8-9 and T9-10 disks in 2 dogs. There was 1 affected disk in 8 dogs and 2 affected disks in 3 dogs. Median number of EAP treatments for dogs in EAP and DSX + EAP groups were 11 and 5 sessions, respectively.

The proportion of dogs with lack of deep pain perception did not differ significantly among groups before

Table 1—Number of dogs with IVDD with long-standing (≥ 48 hours) severe neurologic deficits that had lack of deep pain perception before and at 6 months after initiation of treatment via DSX, EAP, or DSX + EAP.

Group	Time	Lack of deep pain perception
DSX	Before	6/10
	After	6/10
EAP	Before	10/19
	After	4/19
DSX + EAP	Before	8/11
	After	3/11*

*Within a treatment group, proportion differs significantly ($P < 0.05$) from the value before treatment.
n = Number of dogs.

Table 2—Neurologic improvement of dogs with IVDD with long-standing (≥ 48 hours) severe neurologic deficits at 6 months after initiation of treatment via DSX, EAP, or DSX + EAP as determined on the basis of myelopathy score.

	Group		
Myelopathy score	DSX	EAP	DSX + EAP
Unchanged	6/10[a]	4/19[b,A]	3/11[a,b,A]
Improvement*	4/10[a]	15/19[b,B]	8/11[a,b,B]

*Myelopathy score at 6 months after initiation of treatment was less than the myelopathy score before treatment.
n = Number of dogs.
[a,b]Within a row, proportions with different superscript lowercase letters differ significantly ($P < 0.05$). [A,B]Within a column, proportions with different superscript capital letters differ significantly ($P < 0.05$).

treatment (**Table 1**). However, there were significantly fewer dogs with a lack of deep pain perception after treatment with DSX + EAP.

All dogs had myelopathy scores of grade 4 or 5 before treatment (DSX, 4 dogs with grade 4 and 6 dogs with grade 5; EAP, 9 dogs with grade 4 and 10 dogs with grade 5; and DSX + EAP, 3 dogs with grade 4 and 8 dogs with grade 5). However, only 4 of 10 DSX dogs improved to grade 1 by 6 months after surgical intervention. This proportion was significantly less than the proportion of EAP and DSX + EAP dogs that improved to grades 1 or 2 by 6 months after treatment (15/19 and 8/11 dogs, respectively). The proportion of DSX dogs that had no change in myelopathy scores by 6 months after treatment was significantly greater than that for EAP or DSX + EAP dogs (**Table 2**); there was no significant difference in the proportion of EAP or DSX + EAP dogs that had no change in myelopathy scores by 6 months after treatment.

Discussion

Hemilaminectomy is the treatment most commonly used for compressive IVDD[23]; however, EAP was more effective than DSX performed ≥ 48 hours after onset of clinical signs for improving neurologic outcome in dogs with IVDD in the study reported here. This may be explained by the fact that the best results for surgical treatment are achieved when intervention is performed < 48 hours after there is a lack of deep pain perception.[6,7,24–26]

The low number of dogs that had improvement after surgery alone may be explained by the delay between the onset of neurologic signs and the surgical intervention.[24–28] However, there is controversy as to the ideal period for surgical intervention.[29] When surgery was performed between 24 and 48 hours after onset of a lack of deep pain perception, 43% of dogs had neurologic recovery. When surgery was performed 48 hours after loss of deep pain perception, the percentage of dogs with neurologic recovery ranged from 0% to 24%.[24,26] When surgery cannot be performed within 48 hours after loss of deep pain perception or when surgery is not successful,[23,25] EAP alone might be a good option for conservative treatment of dogs with IVDD and myelopathy scores of grade 4 or 5. Although hemilaminectomy alone was performed in 7 of 10 dogs in the DSX group and hemilaminectomy with fenestration was performed in all 11 dogs in the DSX + EAP group, the better neurologic outcome observed for dogs undergoing surgery combined with EAP was probably related to the effect of EAP instead of differences in the surgical techniques used for the 2 groups. In another study,[30] paraplegic dogs treated by use of these 2 surgical techniques had similar outcomes regardless of the type of surgical procedure performed.

Beneficial results have been reported[9,10,14] for the use of acupuncture in the treatment of IVDD. Studies[9,10,15] have revealed that the effects of acupuncture are inversely related to the severity of the clinical signs and neurologic score before treatment. The percentage of dogs classified with grade 1 or 2 IVDD that had clinical improvement after acupuncture treatment ranged between 90% and 100% in several studies.[8–10,15,31] Electrical stimulation of acupoints is indicated when dogs are classified as grade 3 or higher.[8,10] The percentage of dogs with grade 3 IVDD that had clinical improvement after acupuncture treatment for 2 to 6 weeks was 85% in 1 study.[15] For dogs with grade 4 IVDD, only 58% had clinically improved after 10 weeks of acupuncture treatment.[10,32] In the study reported here, the prolonged EAP treatment, which was performed for up to 6 months, may have contributed to a better outcome, compared with results for other studies.[10,32]

A combination of acupuncture and medical treatment provides faster recovery and improvement of ambulation and deep pain perception, compared with results for medical treatment alone.[15] Although we used acupoints similar to those described in another study,[15] the EAP frequency was lower, compared with the alternation of low and high frequency used elsewhere.[15] Low-frequency electrical stimulation is often indicated for patients with chronic conditions and paralysis; in contrast, high-frequency electrical stimulation is indicated for patients with acute onset of clinical signs and pain.[19] Differences in electrical stimulation may have contributed to the better results detected in the dogs of our study, compared with results in other reports.[10,12,15]

Several possible mechanisms may be involved in the effectiveness of acupuncture for treatment of IVDD. Modulation of the immunologic and inflammatory response in the spinal cord is a possible mechanism of action for acupuncture because inflammation appears to be more important than is compression for the development of neurologic signs. This is suggested by the fact that a study[33] involving CT in humans with IVDD in

which the area of compression was measured revealed that there was no correlation between degree of medullar compression and neurologic signs. In some dogs of our study in which IVDD was diagnosed with MRI, we observed that there was no association between grade of compression and neurologic signs. The immunologic and inflammatory explanation for the neurologic events triggered by disk extrusion was also supported by results of other studies[34,35] in which investigators detected lymphocytes, macrophages, metalloproteinase, interleukins, and other mediators at the spinal cord inflammatory site. In addition to the inflammatory modulator effects induced by stimulation of local acupoints, the influence of stimulation of distant acupoints (eg, large intestine 4 and 11 located in the thoracic limb) for segmental activation at C2 and C3 in the cervical portion of the spinal cord has been detected by use of MRI.[36] This result is applicable to the present study because distant acupoints (eg, stomach 36, gallbladder 30 and 34, and kidney 3) were used.

Low-frequency electrical stimulation was performed in this study because it is generally indicated for treatment of medullar compression.[37,38] High-frequency (100-Hz) electrical stimulation may impair disk regeneration. Low-frequency electrical stimulation and rest may reduce disk degeneration, which indicates that the effect of EAP on disk disease is a frequency-dependent phenomenon.[38]

The myelopathy score can be used as an indicator of prognosis after surgery. The percentage of dogs with grades 3 or 4 myelopathy that recovered ambulation after DSX in other studies ranged between 89.5%[26] and 96%.[39] Recovery of ambulation was observed in only 50% of the animals with grade 5 myelopathy when surgery was performed within 36 hours after the onset of the inability to walk.[28] In the study reported here, 6 of 10 dogs with grade 5 IVDD did not improve after DSX alone. This may be explained by the fact that surgery was performed 48 hours after onset of a lack of deep pain perception. In contrast, 15 of 19 and 8 of 11 dogs improved clinically to grades 1 or 2 after treatment with EAP or DSX + EAP, respectively.

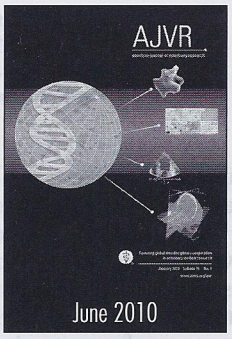
A time-dependent effect on IVDD improvement cannot be disregarded. In a prospective study[33] in 34 humans with disk extrusion, there was a 50% reduction in size of the herniated disk in 18 patients by 18 months after the first CT and a 75% reduction in size of the herniated disk at > 18 months after the first CT. Possible explanations for these results include dehydration, resorption attributable to local inflammation, or retraction of the herniated material into the intervertebral space.[40] This supposition may be supported by the fact that prolongation of the period of conservative treatment reduces the need for surgical intervention after disk extrusion in humans.[41] The authors of that study[33] concluded that the optimal duration for intensive conservative or medical treatment after IVDD should be at least 1 month, thus justifying the use of conservative techniques such as acupuncture before surgery. In the dogs of the study reported here, low-frequency EAP alone or EAP associated with DSX was more effective at causing improvements in neurologic signs and recovery of ambulation than was delayed DSX alone in dogs with grade 4 or 5 IVDD.

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From this month's *AJVR*



Histologic and immunohistochemical evaluation of intestinal innervation in dogs with and without intussusception

Leda M. Oliveira-Barros et al

Objective—To assess viability of innervation in bowel segments appearing macroscopically viable from dogs with intussusception.

Animals—7 dogs without gastrointestinal dysfunction that had been euthanized for reasons unrelated to the study (control dogs) and 13 dogs with intussusception that underwent enterectomy and intestinal anastomosis (affected dogs).

Procedures—A total of 31 samples of intestinal tissue were obtained from the control dogs; 28 samples were obtained from affected dogs during surgery. Samples were histologically and immunohistochemically prepared and subjectively scored for degree of vacuolization and staining, respectively. Other data collected included mean muscle cell density of circular and longitudinal muscular layers, ratio between areas of muscular layers, mean number of myenteric plexuses, mean ganglion cell density of myenteric plexuses, and degree of degeneration in neuronal plexuses as estimated through synaptophysin and neuron-specific enolase (NSE) immunoreactivity.

Results—Mean muscle cell density of longitudinal muscular layers, ratio between areas of muscular layers, and synaptophysin immunoreactivity did not differ significantly between affected and control dogs; values of all other variables did. Correlations were evident between mean ganglion cell density in myenteric plexuses and mean muscle cell density in circular muscular layers, degree of neuronal degeneration in myenteric plexuses and NSE immunoreactivity, and degree of neuronal degeneration in myenteric plexuses and mean ganglion cell density of myenteric plexuses.

Conclusions and Clinical Relevance—Innervation may be impaired in bowel segments that appear macroscopically viable. Therefore, careful evaluation of preserved surgical margins during enterectomy and enteroanastomosis and monitoring of digestive function after surgery are important. (*Am J Vet Res* 2010;71:636–642)

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