

Surgical Decompression in Dogs with Thoracolumbar Intervertebral Disc Disease and Loss of Deep Pain Perception: A Retrospective Study of 46 Cases

By *Outi M. Laitinen, DVM, PhD, Diplomate ECVS* and *David A. Puerto, DVM, Diplomate ACVS*

University of Pennsylvania, School of Veterinary Medicine, Department of Clinical Studies - Philadelphia, 3900 Delancey St. Philadelphia, PA 19104-6010, USA.

Laitinen OM, Puerto DA: Surgical decompression in dogs with thoracolumbar intervertebral disc disease and loss of deep pain perception: a retrospective study of 46 cases. Acta vet. scand. 2005, 46, 79-85. – The case details and outcome after surgical decompression of 46 dogs with thoracolumbar intervertebral disc disease with loss of deep pain perception prior to surgery were reviewed. Nineteen dogs (41.3%) recovered with a median follow-up period of 12.5 months. Recovery was defined as an ambulatory paraparesis, or better, with urinary and fecal continence. There was a better outcome in dogs with loss of deep pain for less than 24 hours prior to surgery (19/41; 46.3% recovered) than in dogs without deep pain perception for more than 24 hours (0/5; 0% recovered). Dogs with deep pain perception present at two weeks postoperatively had significantly higher success rate (8/12; 66.7% recovered) than dogs without deep pain perception at this time period (1/10; 10.0% recovered). The return of deep pain perception by two weeks postoperatively can be a useful positive prognostic indicator.

intervertebral disc disease; deep pain; dog; surgery, spinal cord injury.

Introduction

Thoracolumbar intervertebral disc disease (IVDD) is frequently seen in middle-aged dogs of chondrodystrophic breeds. Clinical signs are variable ranging from mild back pain to hind limb paralysis. Decompressive surgery is a well-established method of treatment for dogs with all grades of neurological dysfunction secondary to spinal cord compression (*Brown et al. 1977, Gambardella 1980, McKee 1992, Scott 1997*).

The prognosis for functional recovery is determined mainly by the severity of injury to the spinal cord. Chondrodystrophic breeds most often have Hansen type I disc disease. This involves rupture of the annulus fibrosus with release of material from degenerated nucleus

pulposus into the vertebral canal. The mass of material extruded as well as spinal canal diameter to spinal cord diameter ratio are important factors in the spinal cord pathology and subsequent clinical signs (*Brown 1977, Seim 1996*). Acute high velocity disc extrusions generally have a more guarded prognosis than the slow disc extrusions (*Prata 1981, Kraus 1996*). Poor clinical outcome is also associated with severe neurological deficits, especially the loss of deep pain perception (DPP) and the duration of its absence (*Duval et al. 1996, Scott & McKee 1999*). Deep pain sensation is carried by non-myelinated fibers of the spinothalamic and spinoreticular tracts deep in the white matter of the lateral and ventral funiculus of the spinal

cord (DeLahunta 1983). As these fibers are relatively resistant to compression, loss of DPP in dogs with IVDD indicates severe spinal cord injury and is considered a poor prognostic sign (Brown et al. 1977, Gambardella 1980, McKee 1992, Toombs & Bauer 1993).

There are few studies with large case numbers documenting the outcome after surgical decompression in dogs lacking DPP (Anderson et al. 1991, Duval et al. 1996, Scott & McKee 1999). Surgery is seldom recommended if DPP has been absent for more than 48 hours (Wheeler & Sharp 1994a, Duval et al. 1996), but the accurate time period for such a recommendation has not been clearly proven.

The purpose of this retrospective study is to report the results of decompressive laminectomy in dogs with thoracolumbar disc disease without DPP and to assess if there are any significant factors that affect the clinical outcome.

Materials and methods

Medical records from the Veterinary Hospital of the University of Pennsylvania (VHUP) were reviewed for dogs that had myelograms performed from January 1996 through June 1999. The inclusion criteria were: (1) complete hind limb paralysis with loss of DPP secondary to thoracolumbar disc disease verified by surgeon(s), (2) surgical treatment by decompressive laminectomy and (3) death or euthanasia as a direct consequence of thoracolumbar IVDD or a minimum of four months of follow-up information. The surgeon determined the presence or absence of DPP by applying pressure to the digits of the hind limb with hemostatic forceps. Repeated behavioral unresponsiveness to the noxious stimulus was regarded as DPP negative. Additional information recorded included signalment, medical therapy such as non-steroidal anti-inflammatory or corticosteroid administration prior to surgery, rate of onset of paralysis, duration of loss of motor

function and duration of absence of DPP. The point of time for loss of motor function was used as the starting time point for calculation of duration of absence of DPP. The rate of onset of hind limb paralysis was graded and grouped as peracute (less than one hour), acute (between one and 24 hours) and gradual (more than 24 hours). Surgical procedure [hemilaminectomy (Wheeler & Sharp 1994 b), or dorsal laminectomy (Toombs & Waters 2003)], surgical findings, whether a durotomy was performed and signs of myelomalacia, were documented. Only dogs that underwent durotomy were intraoperatively evaluated for myelomalacia.

Postoperative treatment was recorded. All paralyzed dogs were managed in a similar manner. Postoperative management included analgesics, bladder management, nursing care to prevent decubital ulcers, cage rest for six weeks and passive range of motion physical therapy.

Outcome was evaluated two weeks postoperatively and at the end of the follow-up period by medical record reviews or telephone interviews with the owners. The neurologic outcome was graded from 0 (paralysis, no DPP) to 5 (normal strength, coordination and sensation) (Anderson et al. 1991). The scale is presented in Table 1. A successful outcome reflecting neurologic

Table 1. The rating scale for neurologic status (based on Anderson et al. 1991).

Grade 5	Normal strength and coordination; deep pain present
Grade 4	Ambulatory paraparesis with mild neurological deficits; deep pain present
Grade 3	Ambulatory paraparesis with obvious neurological deficits; deep pain present
Grade 2	Non-ambulatory paraparesis; deep pain present
Grade 1	Paralysis; deep pain present
Grade 0	Paralysis; deep pain absent

Table 2. The distribution of 46 dogs with thoracolumbar intervertebral disc disease and absence of deep pain perception, by outcome and rate of onset of hind limb paralysis.

Onset of paralysis	Number of cases	Number of successful cases
Peracute (< 1 hour)	7	5 (71.4)*
Acute (1-24 hours)	31	10 (32.3)
Gradual (>24 hours)	8	4 (50.0)
Total	46	19 (40.4)

* Percent

recovery was defined as an ambulatory dog of grade 3 or better with urinary and fecal continence.

Statistical analysis was performed using a commercially available statistical software program (SAS, Version 8.0, SAS Institute, Cary, NC, USA). Chi Square or Fischer's Exact test was used to compare outcome for dogs grouped by various factors. Statistical significance was set at $P < 0.05$.

Results

Signalment – 567 records were reviewed and 46 cases met the criteria for inclusion in the study. Dachshunds comprised 20 dogs (43.5%) of the study population; other breeds represented included Beagle (5 dogs, 10.9%), Lhasa Apso (3 dogs, 6.5%), one each of other chondrodystrophic breeds (5 dogs, 10.9%) and one each of non-chondrodystrophic breeds (3 dogs, 6.5%). There were 10 mixed breed dogs (21.7%) in the study population. The mean age of the affected dogs was 5.3 years (median 7 years, range 3-14 years) and the mean weight was 12.0 kg (median 8.8 kg, range 5.1-38.0 kg). There were 28 females (60.9%) and 18 males (39.1%) in the study population.

Pre-operative factors – No significant differences were found in the clinical outcome neither for dogs grouped by the rate of onset of paralysis (Table 2) nor for dogs grouped by duration of absence of DPP prior to surgery (Table 3). In dogs with no DPP for less than 24 hours ($n = 41$ dogs), neurologic recovery was found for 19 dogs (46.3%) whereas in dogs with no DPP over 24 hours ($n = 5$ dogs), no dogs had a neurologic recovery. However, this difference was not statistically significant ($P = 0.07$).

All dogs included in this study, received steroids as a part of their medical treatment prior to surgery as well as intra-operative cefazolin. None of the dogs received analgetics before being evaluated for DPP. Twenty-seven dogs were treated pre-operatively or intraoperatively with a high dose (30 mg/kg) of methylprednisolone sodium succinate as an i.v. bolus. In 26 of these methylprednisolone was repeated at two and six hours at a dose of 15 mg/kg. Nineteen dogs received varying doses of either prednisone or dexamethasone. The neurologic recovery rate for dogs that received methylprednisolone was 12/27 (44.4%) versus 7/19 (36.8%) for dogs receiving either prednisone or dexamethasone. There was no significant difference in neurologic recovery between the steroid treatment groups ($P = 0.77$).

Table 3. The distribution of 46 dogs with thoracolumbar intervertebral disc disease and absence of deep pain perception by outcome and duration of absence of DPP prior to surgery.

Duration of absence of DPP (hours)	Number of cases	Number of successful cases
< 6	15	4 (26.7)*
6-12	13	9 (69.2)
12-24	13	6 (46.2)
24-48	2	0 (0)
>48	3	0 (0)
Total	46	19 (41.3)

*Percent

Surgical factors – Seven dogs had dorsal laminectomy performed and 39 dogs had a hemilaminectomy performed. No significant difference in neurologic recovery was found for dogs that underwent hemilaminectomy (17/39 dogs, 43.6%) versus dorsal laminectomy (2/7 dogs, 28.6%).

Durotomy was performed in 26 dogs. Durotomy was followed by neurologic recovery in nine dogs (34.6%) whereas 10 out of 20 dogs (50.0%) without durotomy achieved neurologic recovery. The difference was not statistically significant ($P = 0.37$).

At surgery, three dogs (6.4%) were euthanized due to macroscopic lesions indicative of myelomalacia. None of the dogs were sent for necropsy. Neurologic recovery occurred in nine dogs (45.0%) without signs of myelomalacia but did not occur in any of three dogs with macroscopic evidence of myelomalacia and which were not euthanized at surgery. The difference between groups was not statistically significant ($P=0.06$).

Outcome – During initial hospitalization, three dogs were euthanized at surgery and two were euthanized postoperatively. In addition, one dog died due to ascending and descending myelomalacia diagnosed at necropsy. Twenty-two dogs returned for evaluation two weeks post-operatively. Twelve of the twenty-two dogs had DPP present at this time period and these dogs had a significantly higher neurologic recovery rate (8/12, 66.7%) than dogs that had no DPP at the two week follow-up (1/10, 10.0%) ($P=0.01$). Medical record reviews or telephone interviews with the owners were performed on 40 cases. Three dogs were euthanized prior to four months due to lack of any improvement (2 dogs) and self-mutilation (1 dog). Overall, neurologic recovery was achieved in 19 out of the 46 cases included in the study (41.3%) with a median follow-up period of 12.5 months (range

0-51 months). According to the rating scale, the distribution for neurologic status of the recovered dogs was five dogs grade 3, 11 dogs grade 4 and three dogs grade 5.

Complications occurred in 10 (21.7%) of the cases. Postoperatively, three dogs developed progressive myelomalacia of which two were euthanized and one died. Other postoperative complications included urinary tract infection (3 dogs), self-mutilation (2 dogs), second disc rupture followed by surgery at another site (1 dog) and recurrent back pain (1 dog).

Discussion

In the present study, the overall neurologic recovery rate for dogs undergoing surgical decompression with no DPP secondary to thoracolumbar disc disease was 41.3%. Previously, the reported successful outcomes range from 0% to 76% (*Brown et al.* 1977, *Gambardella* 1980, *Anderson et al.* 1991, *Muir et al.* 1995, *Duval et al.* 1996, *Scott & McKee* 1999). Comparing recovery rates with previous studies is difficult because of the many variables, such study inclusion criteria, the duration of absence of DPP and loss of motor function, type of surgery performed and definition of successful outcome. Additionally, the assessment of DPP is subjective; a response to the pressure stimulus should be a withdrawal of the limb with a behavioral response e.g. turning of the head or a crying out. In the current study, only dogs that had no DPP assessed by the surgeon by pinching with a hemostat at the base of the toenail were included in the study in order to minimize the variability in testing and in interpretation of response.

The duration of absence of DPP prior to surgery has been considered a valuable prognostic factor. However, in the referral setting it can be difficult to determine. When we did not have an accurate assessment of the duration of loss of DPP we used the duration of loss of motor func-

tion as a starting point for the time of no DPP. Previous studies have described a better recovery rate (53% - 85%) when duration of loss of DPP has been less than 12 hours compared with loss of DPP 24 to 48 hours (recovery rate 33% - 43%) (Duval *et al.* 1996, Scott & McKee 1999). In another study dogs with loss of DPP over 48 hours did not have significantly worse outcome (Scott & McKee 1999). The most likely explanation for the conflicting findings could be small case numbers. Additionally, variability in assessment of loss of DPP and difficulty in estimating the duration of loss of DPP may explain some of the contradictory results. In the present study, there was a better clinical outcome in dogs without DPP less than 24 hours (45.2% recovery) than in dogs without DPP over 24 hours (0% recovery), but the difference was not statistically significant ($P = 0.06$). The lack of statistical significance is likely a type II error due to a small sample size and distribution. Nevertheless, these results support that a guarded prognosis can be offered to owners of dogs that have lost DPP for less than 24 hours and a poor to grave prognosis should be considered for dogs with no DPP for more than 24 hours.

The rate of onset of paralysis with IVDD has not proven to be predictive of outcome in two studies (Anderson *et al.* 1991, Scott 1997). However, there has been one report where dogs with peracute (less than one hour) onset of paralysis and absence of DPP have had significantly worse outcome (success rate of 22%) than dogs with slower progression of neurologic dysfunction (success rates of 67% - 90%) (Scott & McKee 1999). This may be explained by the fact that a very rapid onset of clinical signs is associated with a sudden extrusion of nucleus pulposus, which can cause variable degree of spinal cord concussion depending on the force velocity and mass of the extrusion. However, in the present study there was a trend

for a better outcome in dogs with peracute onset of paralysis than acute or gradual onset of paralysis. There is no explicit explanation for this finding. In all five dogs with peracute onset of paralysis, except one that recovered, the duration of loss of DPP was more than 12 hours. A limitation of clinical studies is that vascular and reperfusion injuries of the spine which may play a role on the types of injury of peracute versus acute or gradual onset of clinical signs cannot be evaluated. A follow-up study involving a larger number of cases would allow a more accurate evaluation of the significance of the duration of onset of clinical signs.

In the present study only one dog out of 40 with neurologic recovery (2.5%) had recurrence of neurological signs consistent with thoracolumbar disc disease. This dog had a second surgery to remove ruptured disk material from the spinal canal one year after recovery from the first surgery.

The initial rationale for use of corticosteroids was based on the hypothesis that they would prevent post-traumatic spinal cord swelling. Later it was shown that free radical induced lipid peroxidative damage to the cell membranes is the major factor causing secondary tissue destruction after spinal cord injury (Hall 1992). A high dose methylprednisolone regimen has been well established in spinal surgery although a controversy exists concerning the beneficial effects in dogs (Olby 1999). Likewise, experimental studies have failed to show beneficial effects of the use of dexamethasone in spinal cord injuries (Hoerlain *et al.* 1983, Olby 1999). In the current study, corticosteroid therapy was present for all dogs but the dose regime was varied mainly because of the referral setting. Methylprednisolone was given to twenty-eight dogs with a recovery rate of 42.9% (12/28) and dexamethasone or prednisone was administered to 19 dogs with a recovery rate of 36.8% (7/19) with no significant difference be-

tween the groups. Complications associated with these treatments were not evaluated in this study.

Durotomy is most often performed if progressive hemorrhagic myelomalacia is suspected. This lesion is result of a focal progressive, autodestructive process where ischemic and hemorrhagic infarction of spinal cord parenchyma occurs (Coughlan 1993). In the present study, no difference in outcome was seen with durotomy. An experimental study found no benefits when durotomy was performed more than 1 hour after injury (Parker 1975). Durotomy may prove to be most useful in detecting signs of myelomalacia and therefore determining the prognosis for recovery. In this study, none of the three dogs with signs of myelomalacia via durotomy and which were not euthanized at surgery, recovered function. It is authors' opinion that if myelomalacia is present, the prognosis for recovery can be considered very grave.

All dogs that were able to ambulate with control of bowel and bladder function were assessed to have successful outcome. The return of DPP within two weeks after surgery was associated with a higher successful outcome; 66.7% recovery rate versus 10.0% recovery if no DPP at two weeks. This is in agreement with previous studies where return of deep pain sensation or improvement by at least one neurologic grade within two weeks after decompressive surgery was associated with a better prognosis for recovery (Anderson et al. 1991, Scott & McKee 1999).

Conclusion

This study supports the recommendation that dogs with thoracolumbar disc disease without DPP should undergo surgical decompression as soon as possible. The owners should be given a guarded prognosis, but not necessarily discouraged if loss of DPP is within twenty-four hours of treatment. Durotomy can offer useful infor-

mation regarding the prognosis by revealing signs of myelomalacia. The return of DPP within two weeks after surgery is a useful prognostic indicator postoperatively.

Acknowledgement

The authors would like to thank Frances S. Shofer, PhD, Adjunct Associate Professor of Epidemiology and Biostatistics, School of Veterinary Medicine, University of Pennsylvania, for assistance with statistical analysis.

References

- Anderson SM, Lippincott CL, Gill PJ: Hemilaminectomy in dogs without deep pain perception. *California Vet.* 1991, 45, 24-28.
- Brown NO, Helpfrey ML, Prata RG: Thoracolumbar disk disease in the dog: A retrospective analysis of 187 cases. *J. Am. Anim. Hosp. Assoc.* 1977, 13, 665-672.
- Coughlan AR: Secondary injury mechanisms in acute spinal cord trauma. *J. Sm. Anim. Pract.* 1993, 34, 117-122.
- DeLahunta A: General somatic afferent system. In: DeLahunta A, ed. *Veterinary neuroanatomy and clinical neurology*. Philadelphia: W.B. Saunders Company, 1983, 166-174.
- Duval J, Dewey C, Roberts R, Aron D: Spinal cord swelling as a myelographic indicator of prognosis: A retrospective study in dogs with intervertebral disc disease and loss of deep pain perception. *Vet. Surg.* 1996, 25, 6-12.
- Gambardella PC: Dorsal decompressive laminectomy for treatment of thoracolumbar disc disease in dogs: A retrospective study of 98 cases. *Vet. Surg.* 1980, 9, 24-26.
- Hall ED: The neuroprotective pharmacology of methylprednisolone. *J. Neurosurg.* 1992, 76, 13-22.
- Hoerlain BF, Redding RW, Hoff EJ, McGuire JA: Evaluation of dexamethasone, DMSO, mannitol and solcoseryl in acute spinal cord trauma. *J. Am. Anim. Hosp. Ass.* 1983, 19, 216-226.
- Kraus KH: The pathophysiology of spinal cord injury and its clinical implications. *Seminars in Vet. Med. and Surg. (Small Animal)* 1996, 11, 201-207.
- McKee WM: A comparison of hemilaminectomy (with concomitant disc fenestration) and dorsal laminectomy for the treatment of thoracolumbar

- disc protrusion in dogs. *Vet. Rec.* 1992, 4, 296-300.
- Muir P, Johnson KA, Manley PA, Dueland RT: Comparison of hemilaminectomy and dorsal laminectomy for thoracolumbar intervertebral disc extrusion in dachshunds. *J. Sm. Anim. Pract.* 1995, 36, 360-367.
- Olby N: Current concepts in the management of acute spinal cord injury. *J. Vet. Intern. Med.* 1999, 13, 399-407.
- Parker AJ: Durotomy and saline perfusion in spinal cord trauma. *J. Am. Anim. Hosp. Ass.* 1975, 11, 412-413.
- Prata RG: Neurosurgical treatment of thoracolumbar disks: the rationale and value of laminectomy with concomitant disk removal. *J. Am. Anim. Hosp. Assoc.* 1981, 17, 17-26.
- Scott HW: Hemilaminectomy for the treatment of thoracolumbar disc disease in the dog: a follow-up study of 40 cases. *J. Sm. Anim. Pract.* 1997, 38, 488-494.
- Scott HW, McKee WM: Laminectomy for 34 dogs with thoracolumbar intervertebral disc disease and loss of deep pain perception. *J. Sm. Anim. Pract.* 1999, 40, 417-422.
- Seim HB: Conditions of the thoracolumbar spine. *Seminars in Vet. Med. and Surg. (Small Animal)* 1996, 4, 235-253.
- Toombs JP, Waters DJ: Intervertebral disc disease. In: Slatter D, ed. *Textbook of small animal surgery volume I*. Philadelphia: Elsevier Science, 2003, 1193-1209.
- a Wheeler SJ, Sharp NJ: Patient examination. In: Wheeler SJ, Sharp NJ, ed. *Small animal spinal disorders. Diagnosis and surgery*. London: Mosby-Wolfe, 1994, 21-30.
- b Wheeler SJ, Sharp NJ: Patient examination. In: Wheeler SJ, Sharp NJ, ed. *Small animal spinal disorders. Diagnosis and surgery*. London: Mosby-Wolfe, 1994, 85-108.

Sammandrag

Översikt av fallbeskrivningar och utgång efter kirurgisk dekompression hos 46 hundar med thorakolumbalt diskbräck och förlust av djup smärtkänsl. Nitton hundar (41.3%) blev fullständigt återställda med en genomsnittlig uppföljningstid av 12.5 månader. Tillfriskande definierades som ambulatoriskt paraparesis eller bättre med förmögan att avhålla urin och avföring. Bättre utgång noterades hos hundar med förlust av djup smärtkänsl för kortare än 24 h (19/41, 46.3% tillfrisknade), än hos hundar med förlust över 24 timmar (0/5, 0% tillfrisknade). Hundar som hade djup smärtkänsl två veckor post-operativt klarade sig signifikant bättre (8/12, 66.7% tillfrisknade) än hundar med förlust av djup smärtkänsl vid denna tidpunkt (1/10, 10.0% tillfrisknade). Återställning av djup smärtkänsl två veckor post-operativt kan vara en användbar prognostisk indikator.

(Received August 18, 2003; accepted December 20, 2004).

Reprints may be obtained from. Outi M. Laitinen, University of Helsinki, Faculty of Veterinary Medicine, Department of Clinical Veterinary Sciences, P.O. Box 57, 00014 University of Helsinki, Finland.

David A. Puerto, Center for Animal Emergency and Referral Services (CARES), 2010 Cabot Boulevard West, Suite D, Langhorne, PA 19047, USA.