



Spinal Decompression by Hemilaminectomy and Corpectomy-Wrong Side Surgery May Not Affect the Outcome: Preliminary Results

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Abstract

Thoracolumbar Intervertebral Disk Extrusion (IVDE) is a frequent and important cause of paraparesis, paraplegia and urinary incontinence in dogs. This study retrospectively compares the effect of approaching the correct or wrong side and the effect on the outcome. Financial constraints mean that not every surgeon has CT or MRI at their disposal and many owners cannot afford the fees for these advanced imaging techniques. Myelography is still used to make a diagnosis and localize the lesion but the weakness of using myelography is that the right versus left side cannot always be clarified. The wrong side was approached inadvertently in some cases based on the results of myelography due to the inaccuracy of myelography indicating the correct side to operate on. Two similar groups of chondrodystrophic dogs with acute clinical signs of thoracolumbar Intervertebral Disc Extrusion (IVDE) were treated with Hemilaminectomy (HL) for correct side and HL with Corpectomy (CP) for the wrong side. Combining HL with CP for surgical approach for wrong side is a new approach. Analysis was performed to compare the effect that approaching the correct or wrong side in the surgical procedure has on the outcome. An 83.3% successful outcome rate was obtained using the HL or HL/CP procedure irrespective of the side in which the surgery was approached. The biggest cause of poor outcome was the duration of symptoms, independently of the approaching side. The better results were obtained when the acute symptoms were treated before 24 hours. Operating on wrong side does not require a second opening from the correct side to achieve spinal decompression, although the degree of decompression was not analysed. Furthermore, the use of a more extensive decompressive technique produces similar results to HL procedure, even if it is approached from the wrong side.

Keywords: Chondrodystrophic; Corpectomy; Dogs; Hemilaminectomy

Introduction

Thoracolumbar Intervertebral Disk Extrusion (IVDE) is a common spinal disease in dogs, particularly in chondrodystrophic dogs, which

are predisposed to Hansen type I IVDE [1]. Degeneration of the intervertebral disks often is a prelude to disc herniation, which can injure the spinal cord, spinal nerves, or both [2], causing an increase of Intramedullary Spinal Pressure (IMP). Surgical decompression results in an immediate decrease of IMP. Chondrodystrophic breed dogs are prone to IVDE [3,4]. Disc degeneration is inherited by an autosomal dominant mutation due to the two retrogene insertions of functional Fibroblast Growth Factor 4 (FGF4 chromosome 18), involved in many biological processes including bone development [5] and in chromosome 12 (FGF4-12-CDDY) identified in Jack Russell Terriers or Shih Tzu breeds. CDDY mutation is also responsible for the premature degeneration in IVDE [6], which further impacts the animal's health. Moreover, breeds such as Dachshund carry both mutations showing an even more drastic reduction of leg length. The intervertebral disc allows for flexibility of the vertebral column. In chondrodystrophic breeds, the premature calcification of the nucleus pulposus results in degeneration of discs in young dogs, predisposing to herniation into the spinal canal [7].

Hemilaminectomy (HL) is the standard surgical procedure used to treat IVDE by decompression of the spinal cord. Using the dorsolateral approach to the vertebral canal by HL requires manipulation around the spinal cord to remove extruded portions of the intervertebral disc. Dorsal Laminectomy (DL) is also used in non-chondrodystrophic large dogs with thoracolumbar IVDE [8,9]. Ventral spinal cord compression in dogs can be treated with thoracolumbar Corpectomies (HL/CP) [10-12]. Corpectomy (CP) involves the partial removal of thoracic or lumbar adjacent vertebral bodies [13].

Currently, the accepted treatment for this pathology is spinal decompression by HL. However, sometimes the surgical operation is done from the wrong side inadvertently, mainly because if a client cannot afford a cross sectional imaging technique (MRI or CT) then myelography is used which has only 55% accuracy in determining the lateralization [14].

In this study, we compared the outcome in the neurological recovery of chondrodystrophic dogs with acute IVDE treated with HL for the correct side and HL/CP for the incorrect side.

Materials and Methods

A retrospective analysis of clinical records was undertaken to isolate cases with similar presenting symptoms and signalment in chondrodystrophic dog breeds that had HL performed inadvertently on the wrong side of the vertebral column. In the event that a spine was approached from the wrong side, a different surgical technique was employed. In these cases, an additional technique of corpectomy to allow easier access to the opposite side of the spinal cord to retrieve disc material was performed. The corpectomy was performed in accordance with the technique described by Flegel et al. [10] using the same dimensions for bone removal. Fenestration of the affected disc and both discs either side was performed at the same time. This group was compared to a similar group of cases where HL was used to approach the correct side. The results of both groups were compared in order to assess the possible effect in the neurological outcome of surgically treatment from the wrong side.

Ten years of medical records of dogs suffering from acute thoracolumbar IVDD and surgically treated by HL were reviewed. In

this retrospective study, HL was performed on dogs presented with acute thoracolumbar IVDE. Inclusion criteria comprised chondrodystrophic breed, compressive thoracolumbar IVDE confirmed by diagnostic imaging (MRI, CT or myelogram), and similar neurological grade. Breed, age, and sex of each dog, clinical presentation, time elapsed from the first onset of at least paraparesis to the surgical procedure, and outcome of the surgery were collected, as well as if the surgery was approached from the correct or wrong side of the spine.

Duration of clinical signs was defined as the time from when the owner first observed neurological dysfunction until the time of presentation. Based on the severity of neurological dysfunction, dogs were assigned to 1 of 5 neurologic categories, with the categories of the grading system based on the severity of the neurological dysfunction. The surgical technique used to treat the pathology was HL; however, for those surgeries approach by the wrong side, corpectomy with HL was employed.

The neurological status was classified from 0 to 5 [15] according to the clinical examination: Grade 0: Normal; Grade 1: thoracolumbar pain without neurological deficit; Grade 2: Rear limb ataxia, conscious proprioceptive deficit in rear limbs and ambulatory paraparesis; Grade 3: Non-ambulatory paraparesis; Grade 4: Paraplegia with or without bladder control, intact deep pain sensation; Grade 5: Paraplegia, urine retention or overflow, and deep pain sensation loss. The diagnosis and location identification of suspected lesions were achieved using clinical signs and MRI or myelography.

Statistical analysis

The data was analysed using commercially available software (IBM SPSS Statistics Version 23, International Business Machines Corp., Armonk, NY, USA) and results were considered to be significant if $p < 0.05$. The following prognostic factors were evaluated: signalment (breed, age, and sex), neurological grade at initial presentation, duration of clinical signs, and outcomes of surgery.

The first analyses compared the difference between the two groups (correct and wrong side) in terms of the characteristics of the dogs and the main outcomes. Categorical variables were compared between groups using Fisher's exact test. The continuous outcomes were found to be approximately normally distributed, and compared between groups using the unpaired t-test. Duration was considered in two ways. Firstly, it was treated as a continuous variable, and secondly it was categorised as being over or up to 24 hours. Additional analyses examined the association between outcome classification and duration. The unpaired t-test was used to compare duration between the outcome classification groups when duration was considered to be a continuous measure. Fisher's exact test was used to examine the association between groups with duration in categories.

Results

A total of 12 chondrodystrophic dogs were included in the study, with 7 females and 5 males, with a mean age at the time of surgery of 4.25 years (range from 2 to 7 years). The median duration of clinical signs before the surgery was 23.5 hours (range from 6 hours to 48 hours). Before surgery, 8 dogs were diagnosed with grade 3 (66.6%), and 4 dogs with grade 4 (33.3%). Half of the animals underwent hemilaminectomy from the correct side; the other half were approached from the wrong side and had a hemilaminectomy plus corpectomy.

The results from the procedure showed that 83.3% of animals recovered neurological function to a normal stage or had partial recovery understood as having the voluntary ability to ambulate and urinate unaided, while 13.3% of dogs did not recover. No vertebral instability was documented in the treated dogs. No other complications including wound dehiscence, infection or swelling, hemorrhage, nerve root damage or pneumothorax. Demographics data and outcome after surgery are shown in Table 1.

Groups	Breed	Age (years)	Sex	Grade	Duration (hrs.)	Outcome
Correct side	Dachshund	5	m	3	24	N
	Dachshund	7	f	4	36	PR
	Dachshund	3	f	3	24	NR
	Jack Russell Terrier	3	f	4	12	N
	Jack Russell Terrier	2	m	3	24	PR
	Shih Tzu	4	m	3	12	N
Wrong side	Dachshund	6	f	4	24	PR
	Dachshund	5	f	3	36	PR
	Jack Russell Terrier	4	m	3	48	NR
	Jack Russell Terrier	3	f	3	12	N
	Lhasa Apso	4	f	3	6	N
	Shih Tzu	5	m	4	24	N

Table 1: Demographics, grade, duration and outcomes of the hemilaminectomy cases. f: female; m: male. Hours passed since the outset of symptoms until the surgical procedure takes place. N: Recovery to Normal; PR: Partial Recovery; NR: No Recovery.

Neurological categories based on the severity of neurological dysfunction. Grade 1: Back pain without any neurological deficits; Grade 2: Mild to moderate paraparesis, mild ataxia, or conscious proprioceptive deficit; Grade 3: Severe paraparesis; Grade 4: Paraplegia with or without bladder function; Grade 5: Paraplegia with no deep pain perception and incontinence.

In this study, decompression of the spinal cord with low postoperative deterioration, and an 83.3% successful outcome rate were obtained using the HL procedure irrespective of the side correct or wrong in which the surgery was approached. The biggest cause of poor outcome was, in fact, the duration of symptoms and not whether or not the operation approach was by the correct side.

Group comparisons

The comparison between the two groups, correct (group 1) and wrong side surgical approach (group 2), were made in terms of the characteristics of the dogs, and the key outcome variables.

A summary of the group comparisons is shown in Table 2. Continuous variables are presented as the mean and standard deviation; the number of samples and percentage in each group are reported for the categorical variables. Results of the comparison are given as p-values indicating the significance of group differences. P<0.05 was considered statistically significant.

Variable	Category	Correct Side	Wrong Side	P-value
Age	-	4.0 ± 1.8	4.5 ± 1.0	0.57
Sex	Female	3 (50%)	4 (67%)	1
	Male	3 (50%)	2 (33%)	
Grade	3	4 (67%)	4 (67%)	1
	4	2 (33%)	2 (33%)	
Outcome	Normal	3 (50%)	3 (50%)	1
	PR/NR	3 (50%)	3 (50%)	
Duration (hours)	-	22.0 ± 9.0	25.0 ± 15.4	0.69
Duration categorised	≤ 24 hours	5 (83%)	4 (67%)	1
	>24 hours	1 (17%)	2 (33%)	

Table 2: Comparisons between Correct and Wrong side approach surgical groups. Normal: recovery to normal; PR: Partial Recovery; NR: No Recovery.

Neurological categories based on the severity of neurological dysfunction. Grade 1: back pain without any neurological deficits; Grade 2: mild to moderate paraparesis, mild ataxia, or conscious proprioceptive deficit; Grade 3: severe paraparesis; Grade 4: paraplegia with or sincontinence.

The findings suggested no significant differences between the two studied groups for any of the variables assessed. Hours passed since the outset of symptoms until the surgical procedure takes place. Results are shown as mean ± standard deviation, or as number and percentage.

Association between duration and outcome

Additional analyses examined the association between the duration of symptom presentation and the outcome of the surgical procedure. The results of the analyses are summarised in (Table 3). The results suggested a significant association between the duration of symptoms onset on a continuous scale and outcome classification.

The animals that were treated as early as within the first 15 hours less waiting time between the onset of symptoms and the treatment had a normal recovery, a significant better outcome (p=0.007) than those who experienced symptoms for longer time a median of 32 hours before treatment, which only were partially recovered or no recovered (PR/NR group).

Variable	Category/term	Normal	PR/NR	P-value
Duration (hours)	-	15.0 ± 7.3	32.0 ± 9.8	0.007*
Duration categorised	≤ 24 hours	6 (100%)	3 (50%)	0.18
	>24 hours	0 (0%)	3 (50%)	

Table 3: Association between the outcome and the onset of symptoms before surgery.

There was no significant association between duration and outcome classification when duration was considered on a categorical scale. However, although not statistically significant, there was a noticeable variation in the duration categorisation between outcome classification groups. All the animals that recovered had neurological symptoms for

24 hours or less. Four animals that partially recovered had 30 hours of symptoms, while two dogs left for over 36 hours (24 and 48 hours, respectively) did not recover. These results are illustrated in the dot plot graphic representing the duration times against the two outcome classification groups (Figure 1).

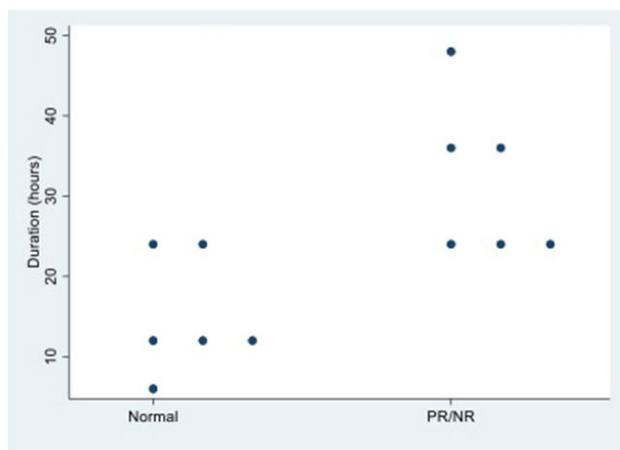


Figure 1: Graphic representing the outcome of the surgical procedure against the time elapsed before they were surgically treated for IVDD. Normal: Recovery to normal; PR: Partial Recovery; NR: No Recovery.

The results suggested little evidence of a difference in the variables between the two groups. However, it should be noted that the sample size is small, and thus there is limited statistical power to show a difference. This is particularly the case for the categorical outcomes, where typically larger sample sizes are required to demonstrate statistical significance. Hours passed since the outset of symptoms until the surgical procedure takes place

Discussion

This study in chondrodystrophic dogs with acute IVDE surgically treated by HL demonstrates that the neurological outcome and improvement of dogs can be independent of the side by which the operation is approach using the additional corpectomy technique. It also showed that the time between the onset of symptoms and the treatment is critical to achieve a better outcome, which can significantly improve if the dogs are treated within the first 24 hours of the onset of the symptoms.

Early on, pediclectomy to treat cases of thoracolumbar disc disease resulted in 59% recovery and 41% of partial recovery or no-recovery [16]. Muir et al. [17] compared the neurological status after HL and DL in chondrodystrophic dogs with thoracolumbar disc extrusion with no significant differences.

It is important to make the distinction between acute and chronic disc disease because the prognosis for recovery may be different with the same surgical technique. In chronic protrusive disc disease, the spinal cord is slowly compressed so that ischemia and degeneration of axons are expected. This pathophysiology is different from the acute contusion encountered in acute extrusive IVDE [18]. Bibevski et al. [19] showed that 87% of chondrodystrophic dog breeds presenting with acute signs of Hansen type I IVDE lesions improved in neurologic grade two weeks after surgery. So, the relevance of the lateralisation only applies in IVDE cases whereas the technique of corpectomy was not intended originally for these types of cases.

Neurological worsening has been described after the treatment of chronic disc disease [19,20]. In a study by Downes et al. [20], 60.7% of dogs showed a neurologic deterioration 24 hours after HL and vertebral stabilization for treatment of chronic disc protrusions.

Ferrand et al. [21] showed neurological worsening in 30.8% of dog 24 hours after HL/CP. These authors found that the preoperative grade had a significant effect on neurological evolution at 24 hours following HL/CP and thereafter. However, in the cases reported here there was no noticeable difference between the two groups following surgery to indicate one or the other caused more morbidity.

It has been reported that standard surgical decompression techniques, such as DL and HL, are not able to adequately decompress the spinal cord in disc herniations in large breed dogs due to the limited ventral access to the spinal canal and a wrapping effect of the spinal cord over the herniated material [13,22]. Although Mini-Hemilaminectomy (MH) has been previously reported to allow better access to the ventral aspect of the spinal canal [23], Huska et al. [24] showed that even in MH, residual pedicle hinders the visualization of central herniations and obstructs the removal of hard lateralized and central herniations. Incomplete decompression following surgery may be common but by using the corpectomy technique decompression is more assured. If a surgeon has in the past had to operate on the correct side following a wrong side approach and HL, then the second side would have a MH instead of a HL. However still the surgical trauma to the patient is high due to bilateral approaches. The comparison between doing a HL and then a contralateral MH and a HL and CP in terms of surgical trauma is unknown, but the authors believe the latter is the lesser of the two options.

Corpectomy (CP) provides a ventrolateral approach but is associated with substantial intraoperative complications [25,12]. Thoracolumbar CP is also known to induce some degree of vertebral instability [26,27]. However, in a retrospective study in dogs with chronic ventral thoracolumbar disc disease treated by HL/CP, Ferrand et al. [21] demonstrated that this technique is a viable surgical option to treat chronic ventral IVDD, even if it leads to several intra and postoperative complications. Potential complications of the HL/CP included spinal nerve injury, vertebral sinus injury or pneumothorax risk in the thoracic region [13]. However in this study there were no major complications recorded associated with corpectomy.

Flegel et al. [10] reported that 90% of cases demonstrated satisfactory spinal cord decompression after surgery without vertebral instability using HL/CP. However, in another study, the authors recommended combining Mini-Hemilaminectomy (MH) with CP if necessary but to avoid HL without spinal stabilization [27]. Other research did not find any clinical indications of instability after CP alone or in combination with MH or HL [11,27,28]. No evidence of instability was noted in this case small case series.

Forterre et al. [29] showed that fenestration reduces the risk of early recurrence of disc herniation and associated postoperative complications in thoracolumbar disc disease Hansen type I in chondrodystrophic dogs treated by HL compared to those treated only with HL and no concomitant fenestration. Another study in chondrodystrophic dogs with intervertebral disc extrusion grade 2-3 using multiple fenestration showed that the probability of dog recovery did not depend on the degree of symptom intensity or on the duration of the disease before the surgical treatment [30]. All dogs in the is study also had fenestration performed at the time of surgery. Studies have shown that delayed postsurgical recovery or deterioration after HL in chondrodystrophic dogs is commonly associated with new or remaining compressive disc material [31]. Residual disc has been shown to be present in all dogs following HL for intervertebral disc disease, although the residual disc was not associated with failure to achieve functional recovery [32]. No follow up imaging was

performed to check for any disc material remaining following surgery and this would be a limitation of this study.

The outcome of a small study of chondrodystrophic dogs with re-herniation of nuclear material 7 days after HL for acute thoracolumbar intervertebral disc extrusion suggested that early re-herniation at the site of previous HL can produce acute deterioration of neurologic function, whereas repeat decompressive surgery can lead to functional recovery [33]. Another research study showed that the grade of intervertebral disc degeneration on Magnetic Resonance Imaging (MRI) was higher in chondrodystrophic dogs than in non-chondrodystrophic dogs, but there were no significant differences in histological grade between both breed groups. They concluded that the intervertebral disc degeneration did not correlate with the neurological severity of herniation [34]. It is possible that some of the cases reported in this study could have deteriorated post-surgery due to re-herniation but this is unlikely because fenestration was performed.

Irrespective of the surgical technique used, it seems evident from the literature that surgical treatments of IVDE achieve better outcome than conservative treatments. In a meta-analysis, Langerhuus et al. [35] portrayed a clear trend to a greater proportion recovering for dogs treated with HL than for dogs treated with conservative treatment (rest, analgesics and anti-inflammatories). The recovery for neurological grades 3, 4 and 5 were 93%, 93% and 61% for those treated with HL, versus 79%, 62% and 10% for those treated conservatively. Even though some of the cases were classified as grade 3 neurological statuses the decision to carry out decompressive surgery was deemed to be the best option for these pets.

Despite what the literature claims, operating on wrong side does not require a second opening from the correct side to achieve spinal decompression [36]. Furthermore, the results from using a more extensive decompressive technique produce similar outcomes. Using the corpectomy technique in this study differs from other published studies in that the corpectomy was performed at only one disc, therefore the risk of instability should be lower.

Comparison with other studies is difficult because of the different number of dogs included in these studies and the variability of the procedures used to treat IVDE. The number of cases is small which is a significant limitation and therefore the results require further verification. Ideally cases of IVDE should have cross sectional imaging such as MRI or CT to eliminate the possibility of operating on the wrong side but cost will mean that myelography may be the only viable alternative. This study suggests that if the wrong side is approached then there is no need to close the surgical site and re open a new approach on the contralateral side.

In conclusion, we found that operating on wrong side does not require a second opening from the correct side to achieve spinal decompression, although the degree of decompression was not analysed. Moreover, our results suggest that the use of a more extensive decompressive technique produces similar results to HL procedure, even if it is approached from the wrong side.

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Conflict of Interest

No conflict of interest.

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