Conservative and surgical treatment of thoracolumbar intervertebral disc disease in dogs: 142 cases

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Abstract

This study was conducted to determine the prognosis for dogs suffering from thoracolumbar intervertebral disc disease. In these retrospective case series 142 cases were included. Only in 21 cases treatment was conservative, on the remaining 121 dogs surgery was performed, i.e. an hemilaminectomy. The neurologic grade was assessed before and 6 weeks after treatment. Dogs clinically graded 3 and 4 pre-surgery, i.e. non-ambulatory dogs with intact deep pain perception, became in 95% (75/79) of the cases ambulatory after surgery. In contrast, only 56% (9/16) of the dogs clinically graded 5 pre-surgery, i.e. with absent deep pain perception, became ambulatory. These results are similar to findings in other studies. Multivariate logistic regression showed that dogs graded 5 pre-surgery (compared to 4), neutered dogs and the French Bulldog had significantly higher odds on unsuccessful outcome, namely 26.3 (P=0.00020), 12.0 (P=0.00998) and 10.6 (P=0.02662) respectively. The outcome of dogs treated conservatively has to be interpreted cautiously, mainly because of the low number of cases.

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Introduction

Background

Intervertebral discs consist of a gelatinous centre (nucleus pulposus) and a surrounding fibrous layer (annulus fibrosus). During normal ageing, the nucleus becomes gradually replaced by chondroid tissue (Hansen e.a., 2017). This is accompanied by a loss of elasticity, resulting in an increase of mechanical forces on the annulus which can result in a protrusion of the annulus into the spinal canal where it presses on the spinal cord. This slowly progressing form of herniation is entitled as Hansen type 2 intervertebral disc disease (IDD) and typically occurs in the caudal cervical and lumbosacral spine.

However, in chondrodystrophic dogs the nucleus matrix degenerates quicker, dehydrates and mineralises, resulting in a susceptibility for acute disc rupture in still young dogs. Mostly the dorsal part of the annulus fibrosus is ruptured, resulting in an extrusion of the nucleus pulposus into the spinal canal (IDD Hansen type 1). This type typically affects one of the cervical (C2-8) or thoracolumbar discs (over 85% in T11-L3) (Sharp & Wheeler, 2005). The spinal canal extradural space is in most places sufficient to allow the accumulation of herniated material without compressing the spinal cord. However, only little space exists in the thoracolumbar part, resulting in more debilitating disease when affected (Nelson & Couto, 2014).

Neurologic deficits of the thoracolumbar spinal cord start typically with losing proprioception, followed by motor function loss if the lesion is more severe and eventually deep pain perception (DPP) will become absent. This is explained by the following two features. Firstly, nerve fibers have different sizes and the thickest are the most susceptible for injury. Proprioception is conducted via the thickest fibers, i.e. with a thick myelin sheath. Motor fibers are intermediate-sized and pain perception is conducted via the thinnest myelinated and non-myelinated fibers, making them the most resistant for injury. Secondly, proprioception fibers are located most superficially and are thus most susceptible to compression. In contrast, pain perception is conducted via crosslinking fibers, located most centrally. Thus, only a deep spinal cord lesion will be accompanied by a loss of DPP (Sharp & Wheeler, 2005).

In a clinical setting, the following grading system is used for assessing severity in thoracolumbar IDD: grade 1: pain, but without neurologic deficits; grade 2: paresis but still walking; grade 3: paresis, not walking; grade 4: paraplegia, DPP present; grade 5: paraplegia and loss of DPP (Sharp & Wheeler, 2005).

When IDD is suspected based on the dog's history and clinical examination, a sometimes difficult choice has to be made. Either a conservative treatment can be started without certainty about the diagnosis, or MRI can be performed, allowing confirmation of the diagnosis. Moreover, imaging is needed to plan the surgical procedure. However, after MRI, conservative treatment can still be chosen for.

Conservative treatment consists of the use of drugs in addition to strict cage rest. Cage rest is recommended for at least 4 weeks, allowing only short walks in a harness for defecating and urinating (Nelson & Couto, 2014). Subsequently, exercise can be gradually increased. Enforced rest is believed to minimise further disc extrusion into the vertebral canal, while allowing the tears in the annulus fibrosus to heal (Fossum, 2018). During the first 3 days, or longer if needed, NSAIDs or narcotic analgesics should be administered to reduce pain and swelling. Also, muscle relaxants can be administered to reduce muscle spasms. Weight reduction should be also considered if the animal is overweight. With time, the herniated material can be absorbed by macrophages (Jeffery, Levine, Olby,

& Stein, 2013; Steffen, Kircher, & Dennler, 2014). Furthermore, via the process of neuroplasticity, nerve fibers can regenerate and new connections can be formed (Dietz & Schwab, 2016; Steffen e.a., 2014). Following this protocol, IDD is often treated successfully; however, recovery rates are poor when DPP is absent (Nelson & Couto, 2014).

After having visualised the anomaly by MRI, the surgical procedure can be planned. By removing the vertebral lamina unilaterally, i.e. a hemilaminectomy, the spinal cord is accessed. Subsequently, herniated material is removed from the spinal canal, which in combination with the earlier removal of bone results in decompression of the spinal cord. Complications include myelomalacia, bleeding, infection and seroma formation (Shores & Brisson, 2017; Fossum, 2018).

Aim

The aim of this study was to determine the prognoses in our clinic (Utrecht University Small Animal Clinic) for both conservative and surgical treatment of IDD. Additionally, the effects of different factors on the prognoses were investigated, i.e.: the gradation based on symptoms (1-5), type of treatment (surgical versus conservative), site of herniation, age, weight, breed, sex and neutering status.

Methods

UKG's medical records from 2013 to 2017 were analysed in this case series study. Dogs with disc herniations between the 10th thoracic and 5th lumbar vertebrae with associated spinal cord compression, confirmed by MRI, were included. Imaging was performed with a high field 1,5 T MRI (Ingenia Philips, Eindhoven, The Netherlands). Radiologists assessed the degree of spinal cord compression for every disc herniation as minimal, mild, moderate or severe. Dogs with multiple disc herniations were excluded, if not one herniation was assessed as causing a higher degree of spinal cord compression than the other(s). However, the dog was included if two herniations causing equal spinal cord compression were derived from directly adjacent intervertebral discs. Other exclusion criteria were: spinal or vertebral tumours, e.g. lymphoma; other abnormalities causing more compression of the spinal cord than the primary disc herniation, e.g. cysts or tissue growth on a previous hemilaminectomy site; severe spondylosis and moderate to severe orthopaedic problems. Furthermore, dogs that died of unrelated causes, e.g. brachycephalic obstructive syndrome, were excluded. Haemorrhage, oedema and hydromyelia that could be linked to the herniated disc were not used as exclusion criteria.

A modified Sharp & Wheeler (2005) scoring system, as shown in table 1, was used pre- and post-treatment.

Grade		Clinical signs
0		-
1		Pain, without neurologic deficits
2	a	Minimal to mild paresis or ataxia. Or minimal to mild decreased proprioception.
	b	Moderate to severe paresis or ataxia but dog still walks. Dog can fall. Proprioception decreased to absent.
3		Severe paresis. Dog cannot walk, at least not more than a few steps.
4		Paralysis in one or both hindlegs.
5		Paralysis with loss of pain perception in one or both hindlegs.

Table 1, a modified Sharp & Wheeler (2005) grading system.

Treatment was evaluated 6 weeks post-treatment. Most dogs were brought to our clinic for a check-up 6 weeks after initialising treatment, making it possible to accurately grade the clinical stage as described in table 1. If the dog didn't appear for a check-up, contact by telephone or a timely email in most cases provided sufficient information to grade the dog's symptoms. Follow-up information was defined as insufficient if the evaluation took place within 6 weeks post-treatment and a grade of 3 to 5 was given at this time and no further evaluations were made. In cases of insufficient information, the referring veterinarian and if necessary the owner were contacted and asked for the 6th week post-treatment. In the pre-treatment non-ambulatory dogs, i.e. grade 3 tot 5, surgery was evaluated as successful or unsuccessful. A post-treatment grade 0 to 2b, i.e. an ambulatory dog, was defined as a successful outcome, grade 3 to 5, a non-ambulatory dog, as unsuccessful.

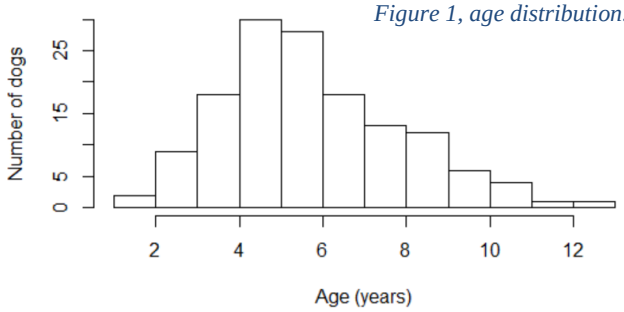
The effects of different factors on the success of surgery were determined in the paralysed dogs, i.e. the dogs graded 4 and 5 pre-treatment. The influence of the clinical grade pre-treatment, site of herniation, breed, weight, age, sex and neutering status on the clinical grade post-treatment were investigated. R's software was used to perform multivariate logistic regression. AIC-based backward selection was used to obtain a model with only statistically significant factors. A P-value of 0.05 was used. The *t*-test was applied for comparing means. Percentages and odds-ratios are provided with 95% confidence intervals (CI).

Results

Descriptive

Based on the in- and exclusion criteria, 142 cases were selected. Enough follow-up data was found in Vetware for 133 cases. For the remaining 9 cases the referring veterinarian was contacted; 4 were unable to give sufficient information and therefore the owner himself was asked.

Figure 1, age distribution.



The Dachshund, French Bulldog, Jack Russel and Shih Tzu were the most commonly affected breeds, accounting respectively for 41% (58 dogs), 9.2% (13 dogs), 7.0% (10 dogs) and 3.5% (5 dogs) of the patients. 13% (18 dogs) were of mixed breed. Chondrodystrophic breeds, as listed by Packer et al., accounted for 68% (97) of the cases (Packer, Hendricks, Volk, Shihab, & Burn, 2013). The dogs were in 90% of the cases 2 to 10 years old, with an average of 5.8 and a median of 5.4 years (see figure 1). Their body weights ranged from 2.8 to 48.0 kg, with an average of 12.2 and a median of 8.5 kg (see figure 2). Intact females accounted for 8% (12) of the cases, female neutered for 35% (50), intact males for 30% (42) and neutered males for 27% (38). The exact locations of the disc herniations is shown in figure 3.

Figure 2, body weight distribution.

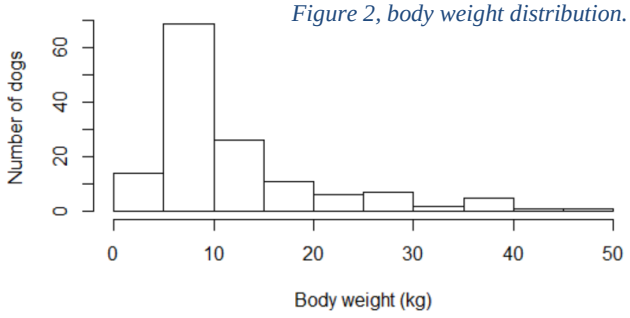
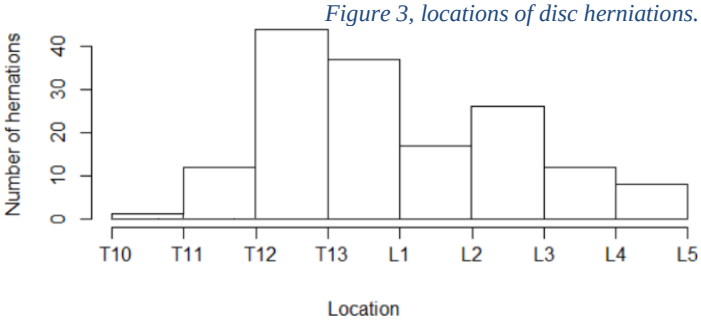


Figure 3, locations of disc herniations.



As logistic regression was only performed on dogs scoring grade 4 and 5 pre-surgery, only for these dogs the type of IDD, i.e. Hansen type 1 or 2, was investigated. In all of these cases the disc herniation was found to be Hansen type 1, i.e. disc extrusions. In most cases the types of IDD were identified by MRI which were later confirmed during surgery. In other dogs, determination could only be achieved during surgery.

Surgery was performed on most of the dogs included in this study (121 dogs), only 21 dogs were treated conservatively. Table 2 shows the number of dogs in every grade before treatment for the two treatment groups. Only 3 dogs graded 4 and no dogs graded 5 were treated conservatively.

		Therapy		Total
		Conservative	Surgery	
Severity	1	1	4	5
	2a	6	2	8
	2b	5	20	25
	3	6	22	28
	4	3	57	60
	5	0	16	16
Total		21	121	142

Table 2, the number of dogs in every grade before treatment for the two treatment groups.

Outcome

The results of conservative treatment and surgery are shown in figure 4 and 5 respectively. All dogs (100%, 22/22, CI: 85.1 – 100%) graded 3 pre-surgery; 93.0% (53/57, CI: 83.3 – 97.2%) of the dogs graded 4 pre-surgery; and 56.3% (9/16, CI: 33.2 – 76.9%) of dogs graded 5 pre-surgery had successful outcome, i.e. became ambulatory, i.e. had a 0 to 2b post-treatment grade.

Multivariate logistic regression showed that dogs graded 5 pre-surgery (compared to 4), neutered dogs and the French Bulldog had significantly higher odds on unsuccessful outcome (see table 3). Age, gender, weight, breed type (chondrodystrophic vs non-chondrodystrophic) and location of the disc herniation were not significantly associated with outcome. The French Bulldogs in these groups were significantly younger than other affected dogs, i.e. 3.0 years versus 5.6 years (P=0,002336) respectively.

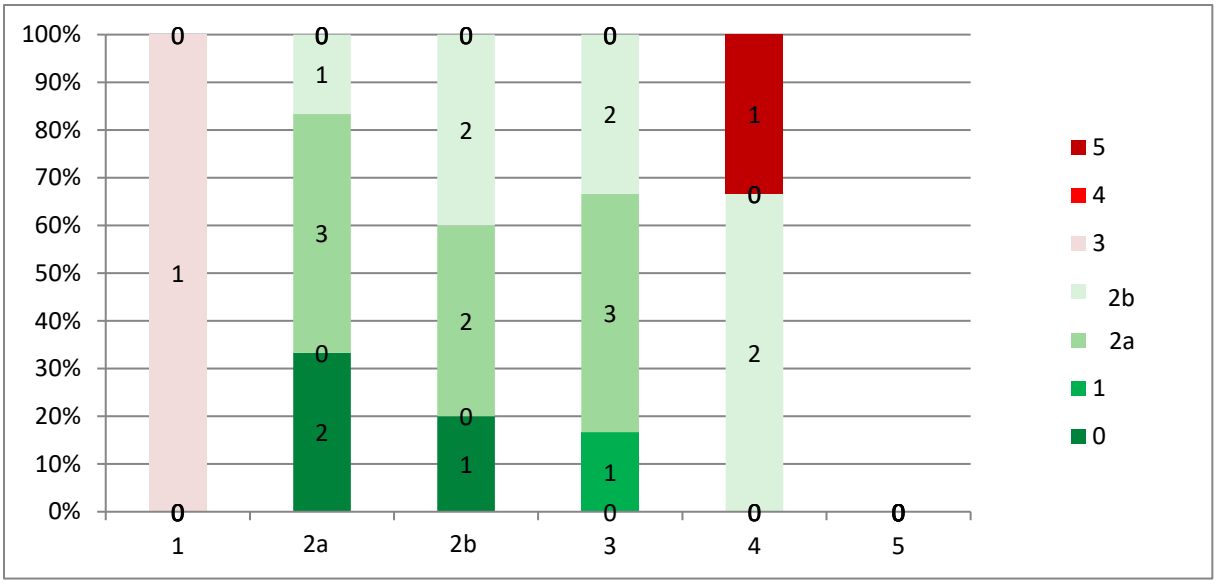


Figure 4, results of the 21 conservatively treated dogs. The grade given pre-treatment is presented on the x-axis. The grade that is given post-treatment is shown by the colour of the bar. Numbers within the bars stand for the exact amount of dogs that are given the specific post-treatment grade. Note the small number of dogs.

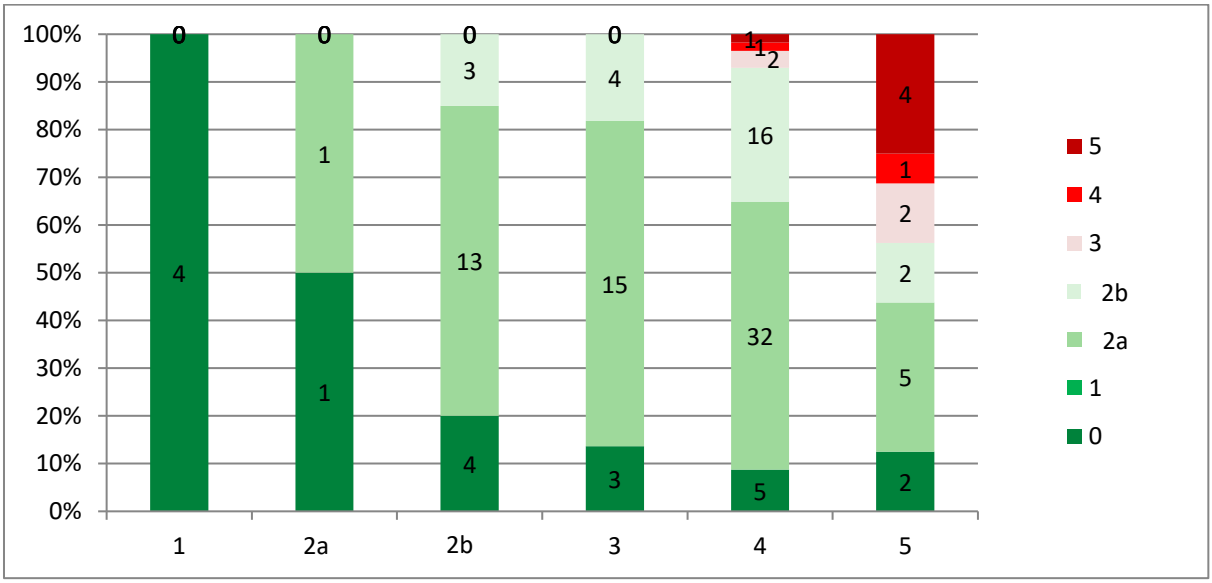


Figure 5, results of the 121 surgically treated dogs. The grade given before surgery is presented on the x-axis. The grade given post-surgery is shown by the colour of the bar. Numbers within the bars stand for the exact amount of dogs that are given the specific post-surgery grade.

	Odds ratio (CI)	P-value
Grade (5 vs. 4)	26.3 (4.4 – 250.0)	0.00020
Neutered (yes vs. no)	12.0 (1.7 – 166.7)	0.00998
Breed (French Bulldog vs. no French Bulldog)	10.6 (1.3 – 100.0)	0.02662

Table 3, results of multivariate logistic regression.

Discussion

The results of this study show that for non-ambulatory dogs with presence of pain perception, i.e. grade 3 and 4, the prognosis is excellent with surgery: 94.9% (75/79, CI: 87.7 – 98.0%) becomes ambulatory, i.e. scores grade 0 to 2b within 6 weeks. If pain perception is absent, i.e. grade 5 dogs, prognosis is poorer: 56.3% (9/16, CI: 33.2 – 76.9%) becomes ambulatory within 6 weeks. These results are similar to findings in other studies (Aikawa, Fujita, Kanazono, Shibata, & Yoshigae, 2012).

The finding that neutered dogs have poorer odds for recovery, has not been described in previous literature. A well-known consequence of neutering is the increased risk of developing obesity (German, 2006). Thus, a possible explanation for this finding is that neutering status is a confounder for obesity, which is a factor that has been linked to orthopaedic problems (German, Ryan, German, Wood, & Trayhurn, 2010). To confirm this hypothesis, future research on the prognosis of IDD should include body condition scores in their analysis.

Paralysed, i.e. grade 4 and 5, French Bulldogs recovered less frequently than other breeds (OR: 10.6 (CI: 1.3-100.0), P=0.027). Aikawa e.a. (2014) had similar results, although these were not statistically significant. However, a significant finding in their study was that French Bulldogs without DPP had higher chances on developing progressive haemorrhagic myelomalacia, i.e. a fatal complication, compared to the Dachshund. Possible explanations for this include a bigger nucleus pulposus and instability caused by vertebral abnormalities which are frequently seen in this breed (Aikawa e.a., 2014). The younger age of the affected French Bulldogs (on average 3.0 years versus 5.6 years in other breeds) was similar to the finding of Aikawa e.a. (2014) (a median of 3 years versus 5 years in Dachshunds).

The outcome of the conservatively treated dogs is difficult to interpret. Firstly, the low number of dogs impairs finding statistically significant differences between the treatment groups. And secondly, these dogs were often patients that were unsuccessfully treated conservatively by the referring veterinarian. Consequently, our group of patients consists of dogs with herniations that are relatively difficult to treat compared to first-line patients.

Previously found factors related to outcome

Dogs with a higher body weight have lower chances on recovery and, besides, more time is needed for recovery (Olby e.a., 2003; Sharp & Wheeler, 2005). Older dogs require more time to recover too (Olby e.a., 2003). A difference in outcome is also found between the two types of IDD. In type I IDD, herniated material, i.e. the extrusions, is easier to remove surgically compared to type II IDD, i.e. protrusions. Furthermore, extruded material that is not removed surgically, is easier absorbed by macrophages compared to protruded material (T. Ito e.a., 1996; Steffen e.a., 2014).

Aikawa, Fujita, Kanazono e.a. (2012) further differentiated dogs with absent pain perception, comparable with grade 5 dogs in our study. It was found that a partial absence of DPP does not indicate a bad outcome. In their study, 99% (76/77) of dogs with a partial absence of DPP but still intact DPP in at least one of the hindlimbs or tail recovered. Of the dogs that had absent DPP in both hindlegs and tail, 52% (110/211) had a successful outcome (Aikawa, Fujita, Kanazono, e.a., 2012).

Ferreira, Correia, & Jaggy (2002) demonstrated that paraplegic dogs that had shown clinical signs for less than 2 days required significantly less time for recovery than dogs that had shown signs for more than 6 days, i.e. 6.7 and 13.6 days respectively. Therefore, early surgery is recommended.

Balducci, Canal, Contiero, & Bernardini (2017) found that herniations located at L5-L6 had higher chances on secondary ascending myelomalacia. As the arteria radicularis magna enters the spinal cord

at this region, it was hypothesized that lesions in this region can cause a large area of ischemia and necrosis, leading to ascending myelomalacia.

Spinal cord hyperintensity on MRI is another factor that has been linked to a negative outcome. It has been shown to be a valuable negative prognostic indicator despite being not very specific, i.e. it can be caused by oedema, inflammation, haemorrhage, gliosis, necrosis or myelomalacia (Ito e.a., 2005; Brisson, 2010; Balducci e.a., 2017).

Cytology of the cerebrospinal fluid has also been suggested as prognostically relevant (Chamisha e.a., 2015). The amount of nucleated cells as well as the number of macrophages were found to be higher in dogs that did not recover.

Inspection of the spinal cord following durotomy during surgery is not a reliable method for evaluating prognosis. A survival of only 5 to 10% of the axons can still be accompanied by functional outcome (Sharp & Wheeler, 2005).

Other treatment options

An additional preventive procedure that is sometimes performed during decompressive surgery is fenestration, i.e. surgically creating a hole in the intervertebral disc where nucleus material can herniate through later in life, instead of herniating to the vertebral canal where it can cause neurological damage (Fossum, 2018). The herniated disc or adjacent discs can be fenestrated, although research data are contradicting (Brisson, 2010). It is not recommended as a single treatment.

Physical therapy is suggested frequently (to help) to treat dogs with IDD (Laitinen & Puerto, 2005; Olby, Halling, & Glick, 2005; Bennaim e.a., 2017). The goals are maintaining a normal range of motion of the joints, reducing muscle atrophy, and improving the degree and speed of neurologic recovery. However evidence for its role in IDD patients is lacking.

Electroacupuncture has been shown to be effective as an additional procedure next to regular conservative treatment (Hayashi, Matera, & de Campos Fonseca Pinto, 2007). Studies show that it improves the degree and speed of recovery (Roynard, Frank, Xie, & Fowler, 2018).

Administration of NSAID's in the intervertebral disc has recently been shown to be effective in treating pain due to IDD; pain was reduced in 9 out of 10 dogs (Tellegen e.a., 2018).

Recently, factors have been found with regenerative effects on the intervertebral disc (Bach e.a., 2017; de Vries, Doeselaar, Meij, Tryfonidou, & Ito, 2018). Substances produced by porcine notochordal cells had positive effects on bovine, canine and human nucleus pulposus cells. Positive effects included an increase in glycosaminoglycan content and a reduction of inflammation (de Vries e.a., 2018). However, additional research is needed to identify the specific active substances and studies have to be done in vivo before this type of regenerative medicine can be used clinically.

Limitations

Determining the neurologic grade was occasionally difficult. For example, the difference between grade 2a and 2b may have been subjective sometimes. In a prospective study, film material could help to classify more strictly. Furthermore, the grade was not explicitly mentioned by the veterinarian but was determined instead by assessing the different veterinarians' descriptions. In 4 cases, follow-up data were acquired by a telephone conversation with the owner.

The hemilaminectomy was performed by different surgeons in our clinic over a five-year period. Consequently, some differences occurred in the exact execution of the surgical procedure. Mortality

during surgery was not investigated and, therefore, dogs that succumbed during surgery were not included in this study. Aikawa, Fujita, Kanazono e.a. (2012) described that 0.8% (7/831) of their dogs died during surgery, mostly because of respiratory arrest due to anaesthesia. Mortality during recovery of causes not related to the herniation was investigated and these cases were excluded in this study; two dogs died during recovery of unrelated causes, i.e. brachycephalic obstructive syndrome and choking in vomit.

The method outcome is presented in this study has, unfortunately, some disadvantages. Firstly, it is quite common for severely affected animals, that eventually recover well, to show no neurologic improvement for the first 7 to 10 days (Jeffery e.a., 2013). As a consequence, some owners could not see through the agony and let their dogs euthanise. Thus, if treatment was continued for more time in the dogs that have been euthanised, more neurologic recovery could have been seen then our results show. And furthermore, Aikawa, Fujita, Kanazono e.a. (2012) described that 13.6 per cent of grade 5 dogs that recovered, required more than 2 months to become ambulatory. Therefore, as our follow up time was only 6 weeks, some cases that are classified as having unsuccessful outcome would probably have recovered eventually. Lastly, the regaining of the ability to walk is not the sole purpose of treatment, it is improving the quality of the dog's life which depends on multiple other factors that will be described below.

First of all, pain can be significantly reduced after treatment, but the neurologic grades 2 to 5 do not take this into account. Consequently, the neurologic grade of some dogs didn't improve despite a dramatic improvement of the quality of life due to the disappearing of pain. Secondly, dogs can suffer from complications or recurrence of clinical signs.

Many affected dogs develop urine and/or faecal incontinence. Furthermore, urine-incontinent dogs are at high risk for developing recurrent urinary tract infections (Olby e.a., 2003). Olby e.a. (2003) and Aikawa, Fujita, Kanazono e.a. (2012) found similar percentages of dogs that developed urine incontinence after recovery from grade 5 neurologic dysfunction, namely 32% and 38% respectively. This number was lower in dogs with less severe neurologic dysfunction, e.g. dogs graded 1 and 2 had a 5.6% chance on developing urine incontinence (Aikawa, Fujita, Kanazono, e.a., 2012). Another complication is self-mutilation, fortunately only seen in grade 5 dogs. It was seen in 2.4% (5/211) of dogs with grade 5 neurologic dysfunction in the study of Aikawa, Fujita, Kanazono e.a. (2012). Because of stress and boredom and an absence of sensation, some dogs started to mutilate their pelvic limbs, back, tail, penis or vulva. Complications of minor importance include infection and seroma formation (Fossum, 2018).

Recurrence of IDD occurs in conservatively and to a lesser extent in surgically treated dogs. With a mean follow up time of 3 years, Levine e.a. (2007) found that 30.9% of the conservatively treated dogs showed signs of recurrence. (Aikawa, Fujita, Shibata, & Takahashi, 2012) described that 2.3% required a second surgery 2 to 61 months after their first one. 10.0% showed recurrence of clinical signs that improved without surgery with a mean follow-up of 45 months (Aikawa, Fujita, Shibata, e.a., 2012).

Conclusion

New treatment options are being investigated, but decompressive surgery remains the treatment of choice for, at least, grade 4 and 5 IDD. In line with previous research, this study shows that with surgery, chances on recovery are good if pain perception is present. If pain perception is absent chances on recovery are poorer. Interestingly, this research shows that IDD behaves different in French Bulldogs, at least with respect to the age of onset and prognosis.

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