A Critical Review into The Rehabilitation Techniques Utilized by Neurological Veterinary Specialists for The Recovery of Dogs Following an Intervertebral Disc Disease Diagnosis

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Introduction

Intervertebral Disc Disease (IVDD) affects between 15-25% of Dachshunds between the ages of 3-6 years old. According to the current research, dogs with IVDD can receive both conservative care (rest and anti-inflammatory/analgesic medicine) and surgical decompression of neural tissue with necessary spinal segment stabilisation. Since neither of these methods can bring back the afflicted spinal segment's biomechanical function, further deterioration is likely to occur, possibly making the segment stiffer which may increase the likelihood of neighbouring segmental disease. The objective of this research project was to identify the most effective course of rehabilitation for canine intervertebral disc disease, this was done by evaluating the experiences of pet owners who have recently had their animals diagnosed in partnership with the experience of veterinary neurological specialists. The primary focus of this research was to recognise any patterns in management which may have improved the rate of functional recovery restoration.

Research published by Leu et al, (2023) found that young French Bulldogs may be predicted to have more than half of their IVDD cases reoccur despite all receiving spinal surgery. An initial episode of Grade 1 IVDD in the cervical spine in French Bulldogs had a 57% recurrence probability. In comparison, the recurrence rate in dogs with Grade 3 thoracolumbar IVDD was 63.3%, yet there was no statistically significant link between the neuro-severity grade and the likelihood of IVDD recurrence. A study by Steele et al. (2015) displayed that isolated lumbar extension (ILEX) enhances metabolic imbalances that may slow or reverse the degenerative process in humans, as well as enhance the health of the lumbar extensor muscles and the lumbar bone mineral density. There is currently a gap in the research on active prevention of future disc degeneration, so future research is required focusing on the effects of utilising strengthening exercises, such as ILEX, as it may result in an adaptive reaction and assist in the repair or regeneration of any effected intervertebral disc in dogs.

What is Intervertebral Disc Disease?

Intervertebral discs (Figure 1) are complex joints situated between each vertebral bone to allow for stability, flexibility, and shock absorption throughout the vertebrae. Each disc consists of longitudinal parallel collagen fibres called the annulus fibrosis (AF) which surrounds a gel-like structure called the nucleus pulposus (NP). Since the early twentieth

century, there has been an association between premature IVDD and dogs with skeletal dysplasia (abnormal development of the cartilage, leading to the dog being short-limbed in proportion to its body), specifically known as chondrodystrophy. Chondrodystrophy in dogs has been connected

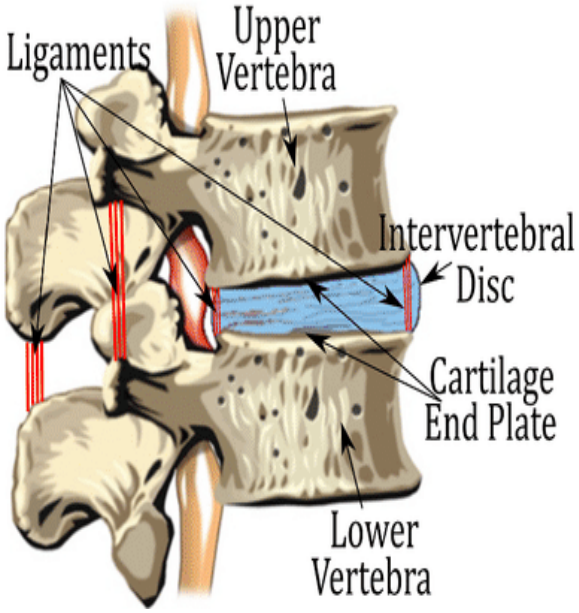


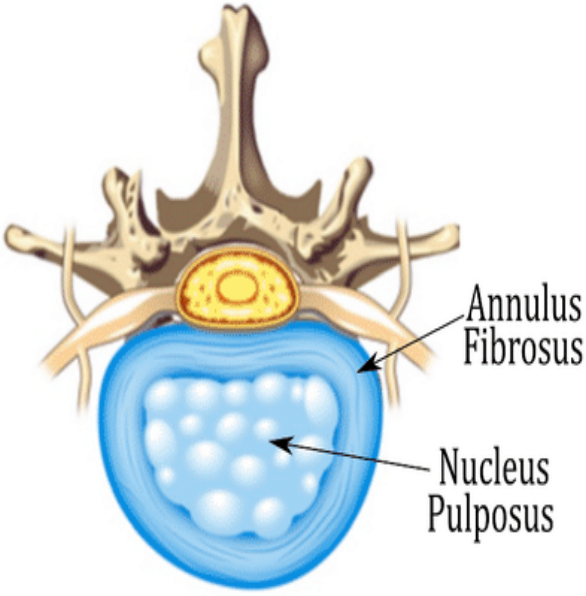
Figure 1 Intervertebral discs anatomy (Thrall & Widmer, 2018)

to mutations in the collagen gene family or its binding proteins. Studies show that two factors have a strong effect on limb length across multiple breeds.

1. Abnormal Fibroblast growth factor 4 (FGF4) levels - overexpression
2. Genetic mutations of FGF4 on chromosome 12

These mutations have also been associated with early intervertebral disc degeneration, which explains the higher presence of chondrodystrophic breeds with IVDD, such as Dachshunds, French Bulldogs, and Beagles.

Between the ages of 3 and 7, Dachshunds that develop acute IVDD are diagnosed with Hansen Type 1, which is categorised as a nucleus pulposus (NP) herniation. The NP in chondrodystrophic dog breeds dehydrates and becomes mineralized as a result of chondroid degeneration. The anulus fibrosis also



degenerates and loses the ability to house the NP, which reduces its capacity to absorb shock, this leads to a sudden extrusion of the dehydrated material onto the vertebral canal roots, which explains why this pathology is acute, painful, and severe.

Table 1 Table demonstrating the clinical signs within Grades 1 to 5 for dogs with a disc extrusion (Dorn, 2022)

Clinical Grade	Clinical Signs

1	Painful				
2	Painful	Wobbly Gait			
3	Painful	Cannot Walk			
4	Painful	Cannot Walk	Paralysed legs	Reduced bladder and bowel control	
5	Painful	Cannot Walk	Paralysed legs	Reduced bladder and bowel control	Loss of deep pain sensation

Table 1 demonstrates how the severity of IVDD is graded, establishing the increase in seriousness as you move up the scale. The sequence of events used to determine prognosis is justified by the anatomical properties of neurological function. Loss of proprioception (awareness of the body in space), loss of motor function (nerve reflexes and mobility), and finally loss of nociception (pain perception) all result from spinal cord trauma in that sequence:

Proprioception

In the event of a spinal cord disease, the motor fibres and ultimately the large-diameter, fast-conducting, myelinated axons are damaged. Thus, ataxia, which results in poor muscle control and clumsy voluntary movements, would be the first clinical indicator of spinal cord damage.

Nerve Reflexes

Normally, the spinal cord allows the brain to send signals to various regions of the body via nerve reflexes, this is what causes movement. However, when a spinal cord is damaged, this information is unable to travel effectively. This means that signals are received by the spinal nerves below the injured level, but they cannot travel up the spinal tracts to the brain. This is what causes dulled or exaggerated reflex responses.

Nociception

Pain perception, which is possible due to the small diameter slow conducting neurons in the spinal cord, is the final function to be lost in cases of spinal injury. Even if the cause of compression is surgically addressed, animals with intervertebral disc disease that have had absent nociception for longer than 48 hours have a poor prognosis.

Participants

Data was collected for this research project via questionnaires, these were constructed for UK-based vets and owners, specifically, Veterinary Neurological Specialists (VNS's) were required to be currently working in a UK-based referral hospital within the neurological department with an active role in IVDD diagnosis and treatment, with experience ranging from 1 to 20+ years, most participants stated they receive at least 10 IVDD patients a month. Owners were also required to be UK-based and have had a dog diagnosed with IVDD within the last 5 years to allow for owners to be able to relay their experience as effectively as possible, the breeds discussed were primarily Dachshunds and French bulldogs, principally who suffered from Grade 4 and Grade 5 IVDD. The project was reviewed, approved, and overseen by the Plumpton College ethics committee.

Results

At the end of data collection, 128 responses were analysed for the owner questionnaires and 39 responses were collected for the VNS's questionnaires. There were 32 Dachshunds, 34 French Bulldogs, 7 Crossbreeds and 2 Other breeds. Dogs were requested to be between 2 and 6, however exact ages at the time of diagnoses were not requested, neither was body condition score or gender.

Symptoms witnessed by owners were sorted into the following categories:

- Lethargy (lethargic, behaviour change, not eating)
- Pain (yelping, shivering, hunched over)
- Paraparesis (uncoordinated gait)
- Hind Paralysis (unable to use hind legs)
- Incontinence
- Full paralyzed
- Other
    - Hard abdomen
    - Faecal incontinence

Table 2 Percentages of symptoms witnessed by owners in relation to which grade the dog was later diagnosed with.

	Lethargic	***Pain***	***Paraparesis***	***Hind Paralysis***	***Incontinence***	***Full Paralyzed***	***Other***
Grade 1	20%	30%	20%	20%	10%	0%	0%
Grade 2	29%	42%	25%	0%	0%	0%	4%
Grade 3	28%	34%	21%	14%	3%	0%	7%
Grade 4	20%	31%	20%	27%	2%	0%	2%
Grade 5	11%	42%	8%	33%	3%	3%	3%

Symptoms observed by the owner were compared against the rate of recovery regardless of grade, surgery, and physiotherapy. Lethargy, behaviour changes, pain, ataxia, paraplegia, and incontinence were the most recognised symptoms, all of which had the highest rate of recovery between 1-3 months (>33%). Faecal incontinence was recognised on two occasions, both of which, the patient took upwards of six months to recover limb functionality.

According to the feedback from the owner questionnaires, 0% of dogs within the Grade 1 category received surgery, whereas Grade 3 upwards had at least an 83% chance of receiving surgery. Dogs with a Grade 5 diagnosis are 20% more likely to receive a hemilaminectomy (removal of part of the vertebrae known as the lamina to relieve pressure on the damaged disc and spinal cord).

Initially, functionality was used as a marker to assess the most effective method of calculating recovery, so this was compared directly to whether the dog received surgery or physiotherapy. There was an association found between surgery and functionality, however, there wasn't an association found between physiotherapy and functionality. Despite this, a large portion of dogs still never recovered full functionality no matter what their management combination was. Interestingly, within the group of responses that stated they didn't fulfil their full physiotherapy programme, there was a 50:50 division whether they recovered within two weeks or not at all. Whereas those that did complete their exercises the most frequent rate of recovery was 1-3 months (32%), yet 29% of said patients still never restored functionality (Figure 2).

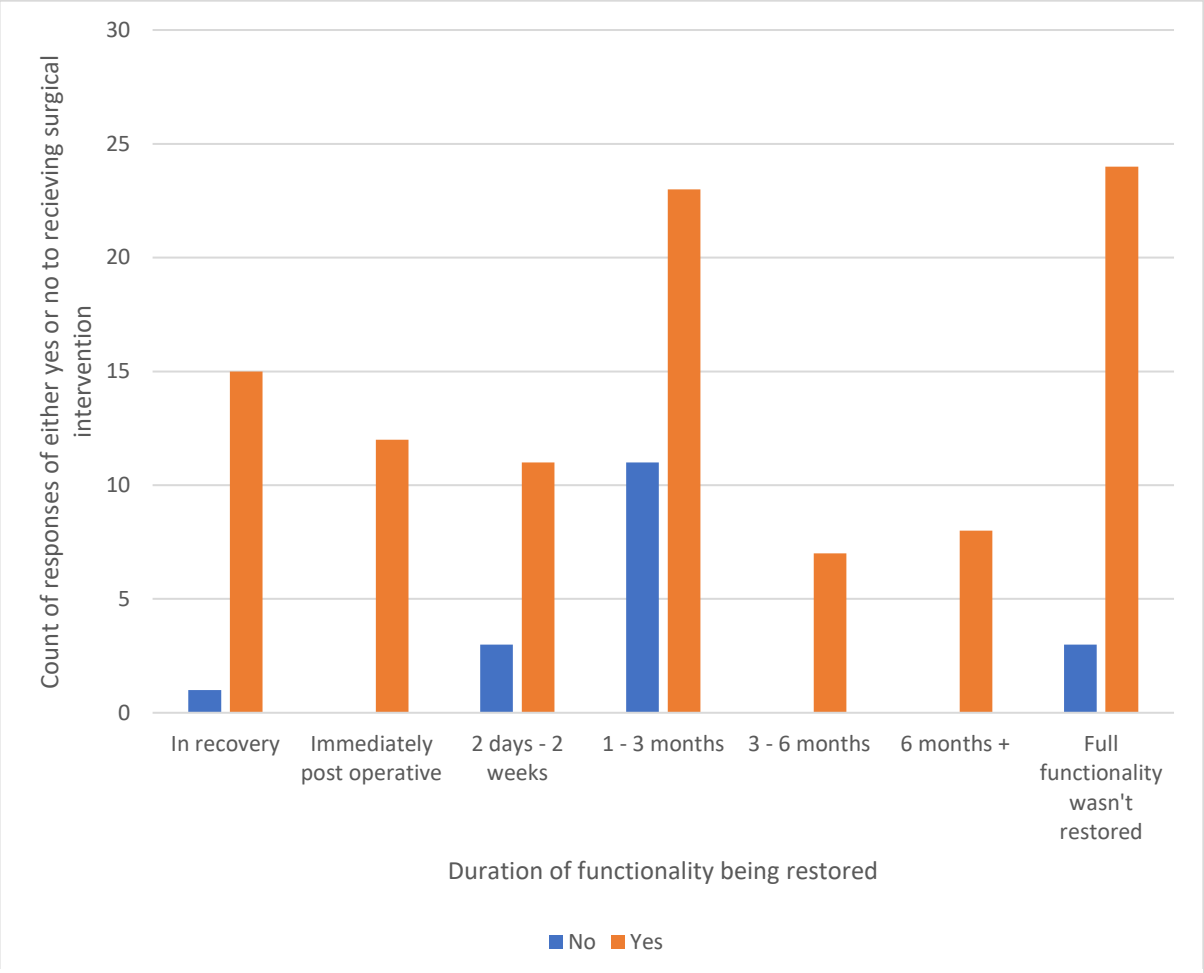


Figure 2 Taken from the owner's questionnaire comparing the duration of functionality to restore to normal against whether the dog received surgery. There was significance found when analysing the relationship between surgery being received and the restoration of functionality (Pearson's Chi-squared test, $\chi 2 = 14.143$, $df = 6$, $p < 0.05$)

From the VNS's perspective, there is an association between how long it takes for full functionality to be restored and the grade of severity. This association was also demonstrated via owner experience where grade is statistically related to the timeline of functionality being restored, 1-3 months being the most recognised timeline for recovery. VNS's were asked how long before they expect their patients to regain functionality, 75% stated they would expect Grade 2/ambulatory patients to recover immediately post-operative and 75% stated that Grade 4/non-ambulatory/deep pain present would recover functionality within two weeks. Only 14% stated that functionality may never be restored for Grade 5/deep pain negative patients, the more anticipated time frame was either 3-6 months (29%) or 6 months (29%). According to owner feedback, 100% of patients diagnosed with Grade 1 had functionality fully restored within 3 months, whereas 63% of Grade 5 patients never regained full functionality (Figure 3).

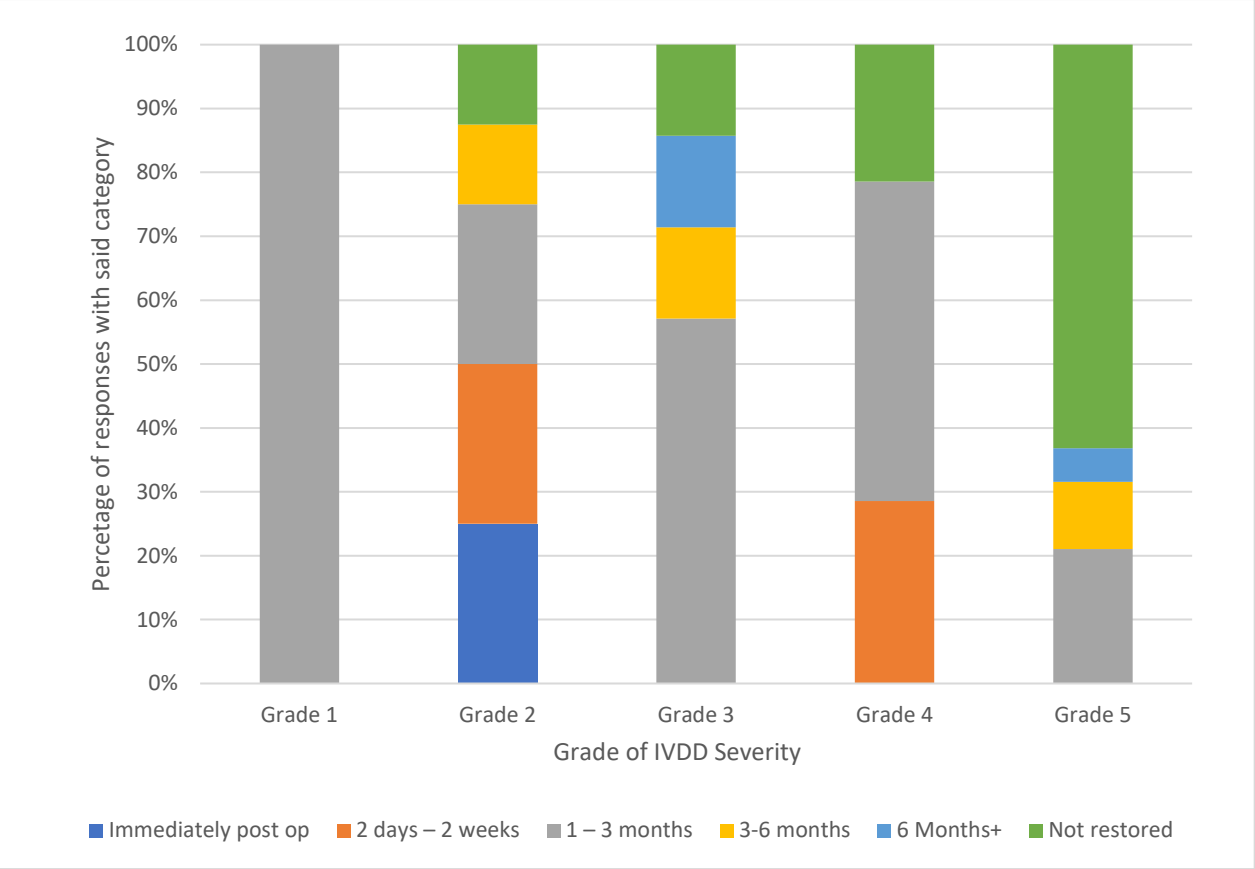


Figure 3 Taken from the owner's questionnaire, comparing the Grade of severity vs how long it took for functionality to be restored. Grade is statistically related to the timeline of functionality being restored. 1-3 months is the most recognised timeline for recovery, (Fisher's Exact Test for Count Data, p< 0.01

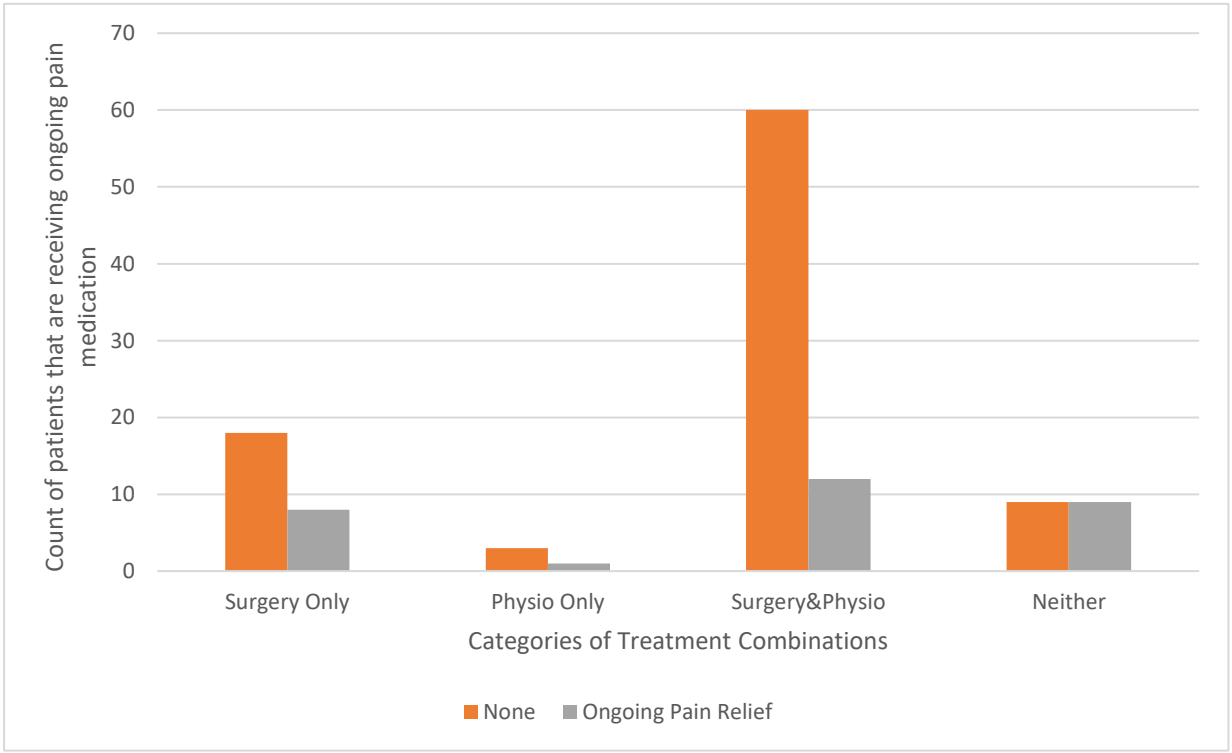


Figure 4 Taken from the owner questionnaire, comparing whether owners stated that their dogs required pain relief from their vet and if they received surgery only, physiotherapy only, surgery and physiotherapy, or neither (Pearson's Chi-squared test, $\chi 2 = 9.1282$ df = 3, $p < 0.05$).

A critical finding from this study is that 86% of dogs that received physiotherapy did not require ongoing pain management (OPM), whereas the group that didn't receive physiotherapy was close to being a 50:50 split between needing and not needing pain management. Overall, 83% of dogs that received both surgery and physiotherapy did not require OPM, whereas the group that received neither physiotherapy or surgery had a 50:50 split between needing and not needing pain management. In the group that received surgery only, 69% of patients did not require any OPM, however, in the group that received physiotherapy only, 75% did not require any OPM (Figure 4)

Discussion

This study demonstrates a correlation between IVDD-graded severity and the duration of recovery, which is the case irrespective of whether surgery or physiotherapy was used (Figure 5). In cases where dogs were diagnosed with Grade 2 and over, there is a chance that the dog will never restore full function, the likelihood of which increases as the grade becomes more severe. As per VNS input, for deep pain perception (DPP) positive

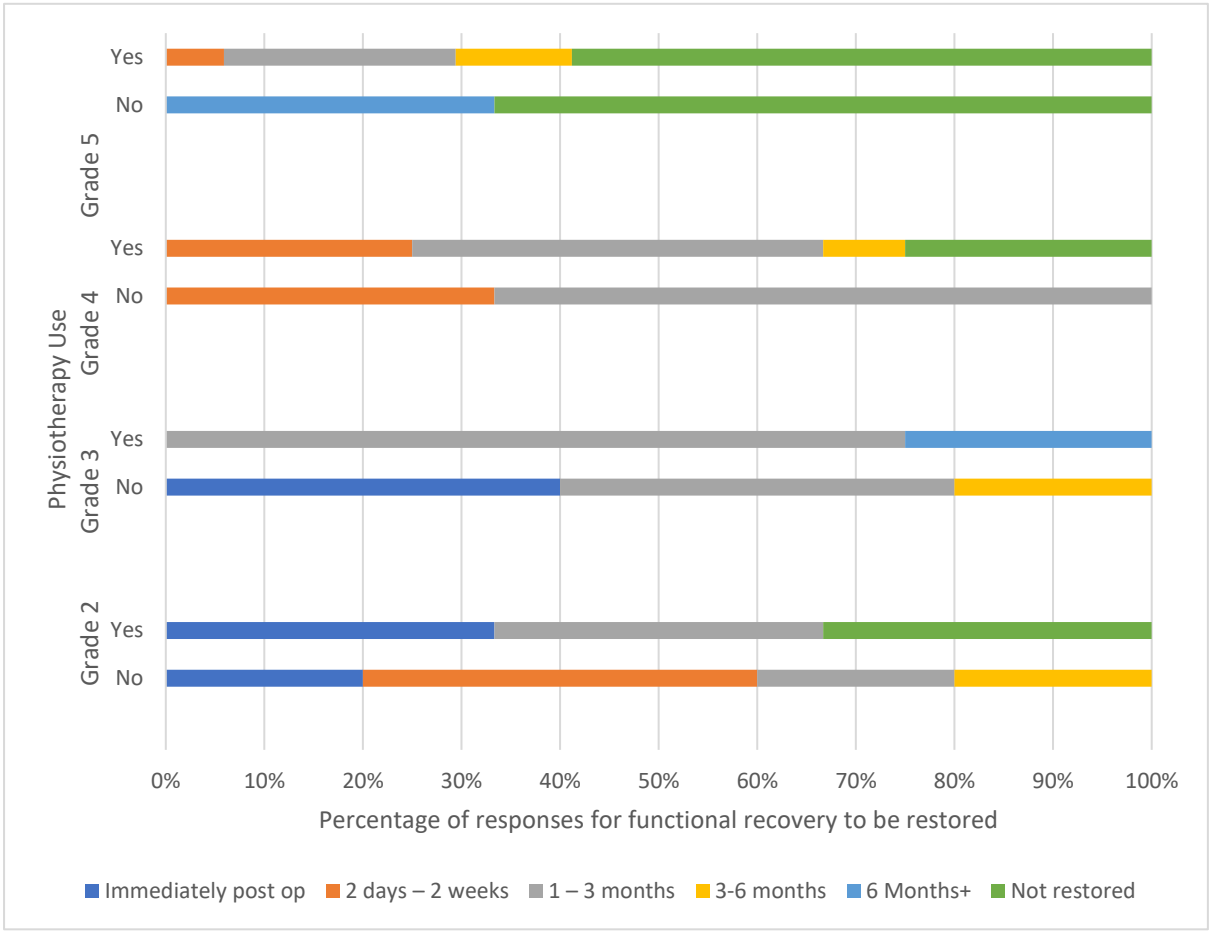


Figure 5 Taken from the owner questionnaire, comparing the rates of recovery within categories of graded severity.

patients, recovery is anticipated to occur immediately or within two weeks at most, and for deep pain perception (DPP) negative patients, the worst-case scenario is six months. However, first-hand experience from owners does not mirror this prediction, with the most represented time frame for recovery for DPP-positive to be 1-3 months, with a percentage less than 30% recovering within two weeks, and most DPP-negative patients not restoring full functionality at all. This striking discrepancy between expectation and reality highlights the need for more research to completely comprehend the complexities of IVDD recovery for VNS's to successfully treat patients and counsel clients on what to anticipate from the process.

The relationship between symptoms seen by owners and the time it took for their dog's functionality to return is an important finding from this study. Although there is some evidence in previous studies that the duration of symptoms may affect how quickly a patient recovers, there is no universal agreement on the impact of the speed at which symptoms appear or how long they last. This study found no evidence that surgery performed on the same day demonstrated an improved outcome compared to surgery being performed up to seven days later, simply that a greater severity of grade increased the risk of the dog never restoring full function.

Regarding physiotherapy, the results of this review illustrate that patients who recovered within the 1–3-month window either did not perform any physiotherapy exercises or performed three exercises that included strengthening. Passive range of motion (PROM) was a common exercise used by VNS's for postoperative patients, with the main benefits of PROM being to protect against stiffening or fibrosis of the joint as well as to prevent cartilage atrophy, replenish the synovial fluid, improve local circulation, and stimulate sensory and motor nerves. However, it is important to note that dogs that only received PROM as an exercise had a higher chance of not recovering mobility; this may indicate the necessity for greater focus on strengthening exercises rather than only employing PROM.

This review demonstrated that the implementation of VP did not improve the functional outcome overall as 39% of patients that received VP did not restore full functionality, however as grade severity is increased within the VP group, this evaluation is unable to verify if VP affects the rate of recovery in post-operative and conservatively treated dogs across the graded severities. The

impact of physiotherapy should be noted when examining each grade separately. Despite there not being a statistically significant value present, the results demonstrated that the percentages of functionality being restored have a 6% increase within the Grade 5 group that did utilise a physiotherapist, so demonstrating a need for further research to assess the restoration in functional mobility in Grade 5 dogs only.

Overall, the scope of this research paper was not able to identify one specific rehabilitation protocol most effective for IVDD recovery. This is due to each rehabilitation program's effectiveness depending on a variety of variables, including owner compliance, treatment interventions, the degree of severity, the presence of symptoms prior to diagnosis, and, most importantly, the unique characteristics, requirements, and preferences of each patient.

Conclusion

The main takeaway from this research is due to the individual nature of VP, it is very difficult to assess the most effective course of action to improve recovery, and owners of IVDD patients could do everything theoretically correctly in relation to surgery, rest, and physiotherapy and yet due to the severity of the herniation, their dog may still never restore full function. However, in order to give dogs, the best chance at not requiring long-term pain medication following an IVDD diagnosis, the combination of surgery and physiotherapy has shown to be incredibly effective.

This study demonstrates a need for more thorough research into the most effective protocols of rehabilitation for dogs suffering from IVDD and the elements that can either worsen or aid in recovery outcome times. Meanwhile, ongoing management will likely be required to discourage the reoccurrence of corresponding discs within the vertebrae, although the most effective methods need to be studied in a quadruped species to confirm if this is something that can be proven successful.

Overall, the results support the use of VP for IVDD patients to reduce the need for ongoing pain management to be used, as well as a greater outcome being achieved when strengthening exercises were utilised as well as PROM. The complexity of IVDD rehabilitation and treatment strategies was also underlined, emphasising the need for greater study in order to produce the most efficient durations, frequencies, and processes that may be defined and then modified to accommodate the individual.

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