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DISTRIBUTION OF INTERVERTEBRAL DISC EXTRUSIONS IN DOGS: A RETROSPECTIVE CASE SERIES STUDY

LÜLIVAHEKETTA VÄLJASOPISTUSE ESINEMINE KOERTEL: RETROSPEKTIIVNE JUHTUMITE ANALÜÜS

Final Thesis
Curriculum in Veterinary Medicine

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Tartu 2025

Estonian University of Life Sciences

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Abstract of Final Thesis

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Curriculum: Veterinary Medicine

Title: Distribution of intervertebral disc extrusions in dogs: a retrospective case series study

Pages: 41	Figures: 9	Tables: 1	Appendixes: 1

Chair: Chair of Clinical Veterinary Medicine

Field of research and (CERC S) code: 3. Health, 3.2. Veterinary Medicine

B750 Veterinary medicine, surgery, physiology, pathology, clinical studies

Supervisor(s): Toomas Orro, Janis Jeserevics, Janis Baltkajs

Place and year: Tartu 2025

Intervertebral disc disease (IVDD) is a prevalent neurological disorder in dogs, particularly affecting chondrodystrophic breeds. The condition results from disc degeneration and herniation, leading to painful spinal cord compression and neurological deficits. This retrospective case series describes the clinical features, diagnosis, treatment, and outcomes of 55 dogs diagnosed with intervertebral disc extrusion (IVDE) at Aisti Animal Hospital between September and October 2024. The patient data was obtained from Aisti Animal Hospital's ProvetCloud and analysed with Microsoft Word. All dogs had magnetic resonance imaging done for improved diagnostic accuracy. Most of the disc extrusions were located between vertebrae T3 and S3. Dachshunds were the most commonly affected breed, making up 42% of cases. The most frequent neurological signs were paraparesis and paraplegia and the most common neuroanatomical localization was found to be between T12 and T13 vertebrae. Surgical treatment using minihemilaminectomy was performed in 62% out of the study group patient cases, with generally good recovery. Conservative treatment included restriction of movement, analgesia, and physiotherapy, and was chosen as a treatment with 32% of the patients. Three individual case studies illustrated the range of outcomes, including one recurrence. The study findings are consistent with existing research on breed predisposition, clinical presentation, and treatment outcomes in dogs with IVDE.

Keywords: intervertebral disc disease, intervertebral disc extrusion, dog

Eesti Maaülikool

Kreutzwaldi 1, 51014, Tartu

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Õppekava: Veterinaarmeditsiin

Pealkiri: Lülivaheketta väljasopistuse esinemine koertel: retrospektiivne juhtumite analüüs

Lehekülgi: 41	Jooniseid: 9	Tabeleid: 1	Lisasid: 1

Õppetool: kliinilise veterinaarmeditsiini õppetool

ETIS-e teadusvaldkond ja CERC S-i kood: 3. Terviseuuringud, 3.2. Veterinaarmeditsiin

B750 Veterinaarmeditsiin, kirurgia, füsioloogia, patoloogia, kliinilised uuringud

Juhendaja(d): Toomas Orro, Janis Jeserevics, Janis Baltkajs

Kaitsmiskoht ja -aasta: Tartu 2023

Lülivaheketta haigus (IVDD – *intervertebral disc disease*) on koerte seas levinud neuroloogiline häire, mis mõjutab eriti kondrüstroofseid tõuge. See seisund tuleneb lülivaheketta degeneratsioonist ja songist, mis põhjustab valulikku seljaaju kokkusurumist ja neuroloogilisi defitsiite. Käesolev retrospektiivne juhtumite analüüs kirjeldab 55 koera kliinilisi tunnuseid, diagnoosi, ravi ja tulemusi, kellel diagnoositi Aisti Loomakliinikus 2024. aasta septembrist oktoobrini lülidevaheketta väljasopistus (IVDE – *intervertebral disc extrusion*). Patsientide andmed saadi Aisti Loomakliiniku ProvetCloudist ja analüüsiti Microsoft Wordi abil. Kõigile koertele tehti diagnostilise täpsuse parandamiseks magnetresonantstomograafia. Enamik ketta väljasopistusi asus selgroolülide T3 ja S3 vahel. Taksikoerad olid kõige sagedamini haigestunud tõug, moodustades 42% juhtudest. Kõige sagedasemad neuroloogilised tunnused olid paraparees ja parapleegia ning kõige levinum neuroanatoomiline lokalisatsioon leiti olevat T12 ja T13 selgroolülide vahel. Kirurgiline ravi (minihemilaminektoomia) teostati 62%-l patsientidest ja üldiselt oli taastumine hea. Konservatiivne ravi hõlmas liikumise piiramist, valuvaigistust ja füsioteraapiat ning seda kasutai 32%-l patsientidest. Kolm individuaalset juhtumit illustreerisid erinevaid tulemusi, sealhulgas ühte kordumist. Uuringu tulemused on kooskõlas olemasolevate uuringutega IVDE-ga koerte tõulise eelsoodumuse, kliinilise pildi ja ravitulemuste kohta.

Märksõnad: lülivaheketta haigus, lülidevaheketta väljasopistus, koer

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LIST OF ABBREVIATIONS

AF – annulus fibrosus

ANNPE – acute non-compressive nucleus pulposus extrusion

CD – chondrodystrophic

CNS – central nervous system

CSF – cerebrospinal fluid

CT – computed tomography

DPP – deep pain perception

EP – cartilaginous endplates

FCEM – fibrocartilaginous embolic myelopathy

HNPE – hydrated nucleus pulposus extrusion

IIVDE – intradural or intramedullary intervertebral disc extrusion

IVD – intervertebral disc

IVDD – intervertebral disc disease

IVDE – intervertebral disc extrusion

MRI – magnetic resonance imaging

NCD – non-chondrodystrophic

NP – nucleus pulposus

SCI – spinal cord injury

INTRODUCTION

Intervertebral Disc Disease (IVDD) is a common neurological disease in dogs, especially in chondrodystrophic breeds. Most often affected breeds are Dachshunds, Welsh Corgis (Pembroke and Cardigan), and excessively inbred French Bulldogs (Spitzbarth et al., 2020). It usually results from degeneration and herniation of intervertebral discs, leading to compression of the spinal cord. The herniations can be referred to Hansen type I, acute rupture or explosive extrusion, or to Hansen type II, known as chronic protrusions or bulging protrusions. Both types cause pain and neurological deficits in affected dogs. Type I is more common in younger dogs whereas the type II affects more older dogs (Kranenburg et al., 2012; Olby et al., 2020; Wang-Leandro et al., 2020).

The pathophysiology of IVDD is multifactorial, involving genetic predisposition, biomechanical forces, and inflammation. Studies have shown that genetic mutations in fibroblast growth factors play a significant role in the early degeneration of discs in chondrodystrophic breeds (Obly et al., 2020). When the intervertebral disc herniates, it causes both mechanical compression and an inflammatory response in the spinal cord, leading to neural damage (Bergknut et al., 2020).

Diagnosis of IVDD is based on the presented clinical signs and diagnostic imaging techniques like Magnetic Resonance Imaging (MRI) or Computed Tomography (CT). Depending on the severity of the case, the treatment options are conservative treatment, including restriction of movement, and pain medications, and surgical treatment, meaning hemilaminectomy, and minihemilaminectomy (Jeffery et al., 2020).

1. LITERATURE REVIEW

1.1 Characteristics of intervertebral disc extrusion

Intervertebral disc extrusions are a painful disease in dogs involving the displacement of intervertebral disc material, nucleus pulposus, through a rupture in the annulus fibrosus, typically resulting in spinal cord compression and neurological signs. The signs include pain, paresis, or paralysis and retention incontinence. Canine intervertebral disc extrusion is a spontaneous disease with a high inter-individual variability (Spitzbarth et al., 2020; Olby el al., 2022).

Nowadays the intervertebral disc diseases can be classified into eight categories, shown in detail in T: IVD extrusion, which can be known as the Hansen type I or acute extrusion; IVD protrusion, also known as Hansen type II or chronic protrusion; acute IVD extrusion with epidural hemorrhage; acute non-compressive nucleus pulposus extrusion (ANNPE); hydrated nucleus pulposus extrusion (HNPE); intradural/intramedullary IVD extrusion (IIVDE); traumatic IVDE; fibrocartilaginous embolic myelopathy (FCEM) (Fenn et al., 2020).

Table 1. The terminology used in veterinary literature to describe different types of intervertebral disc disease (IVDD) (Fenn et al., 2020)

IVDD type	Terminology used in veterinari literature
Hansen Type I / Acute IVD extrusion	Hansen Type I IVD herniation
	Hansen Type I IVD extrusion
	Hansen Type I IVD disease
	Acute IVD herniation
	Acute IVD extrusion
	Acute IVD disease
	IVD protrusion
	Type I protrusion/prolapse
Hansen Type II / Chronic IVD protrusion	Hansen Type II IVD herniation
	Hansen Type II IVD protrusion
	Hansen Type II IVD disease
	IVD protrusion
	Type II protrusion/prolapse

Acute IVD extrusion (Hansen Type I) with extensive epidural hemorrhage	Acute IVDE with extensive epidural hemorrhage Disc extrusion with extensive epidural hemorrhage (DEEH)
Acute non-compressive nucleus pulposus extrusion (ANNPE)	Acute non-compressive nucleus pulposus extrusion (ANNPE) Hansen Type III IVDD High-velocity, low-volume IVD extrusion Traumatic IVD extrusion IVD explosion Traumatic IVD prolapse Missile discs
Hydrated nucleus pulposus extrusion (HNPE)	Hydrated nucleus pulposus extrusion (HNPE) Hydrated nucleus pulposus herniation Acute compressive hydrated nucleus pulposus extrusion Partially degenerated disc extrusion Intraspinal cyst Canine discal cyst
Intradural / intramedullary IVD extrusion (IIVDE)	Intradural/intramedullary IVD extrusion (IIVDE) Intradural IVD herniation Intramedullary IVD herniation Intramedullary IVD extrusion
Traumatic IVD extrusion	Traumatic IVD extrusion Traumatic IVD prolapse
Fibrocartilaginous embolic myelopathy (FCEM)	Fibrocartilaginous embolic myelopathy (FCEM) Fibrocartilaginous embolism (FCE) Ischaemic myelopathy Spinal cord infarction

1.1.1. Prevalence

The lifetime prevalence of IVD herniation in dogs is around 2% and the risk of IVD degeneration is found to increase with age. In chondrodystrophic dogs, a lifetime prevalence of IVD degeneration is found to be 20% in Miniature Dachshunds, and 15% in Standard Dachshunds according to Bergknut et al. (2012). Bergknut's study (2012) also stated that German Shepherd dogs had the highest risk of 7% of lumbosacral IVD degeneration. Cervical herniations are less common, approximately considered to be 14-35% of all cases (Spitzbarth et al., 2020). High physical workload could accelerate the IVD degeneration in dogs. Overall IVDD related case fatality rate is 34% according to Bergknut et al. (2012).

Acute and severe thoracolumbar spinal cord injuries account for 4% cases presented in emergency rooms in North America according to Olby (2020). IVDD is being responsible for 2.3-3.7% of admissions to veterinary hospitals in total after by da Costa (2020).

1.1.2. Morphology and physiology

The intervertebral disc is a cartilaginous joint or symphysis uniting 2 adjacent vertebrae and facilitates limited spinal movement. The disc comprises of central nucleus pulposus, surrounding annulus fibrosus and the cranial and caudal cartilaginous endplates (Murphy et al., 2019). Nucleus pulposus is composed of gel-like substance rich in water, proteoglycans, type II collagen, all together acting as a shock absorber and allowing flexibility of the spine. Annulus fibrosus is made from type I and type II collagen fibers, and fibrocartilage contributing to the resilience and ability to receive forces, providing stability and strength. The NP is surrounded by the AF which is a dense network of multiple concentric fibrous lamellae. The ventral part of the AF is thicker than the dorsal part. Near the center of IVD, the AF becomes more cartilaginous and less fibrous. The cranial and caudal borders of the IVD are formed by the cartilaginous endplates (EP). EPs are connected with fibres of the inner AF, whereas the fibres of the outer AF are connected with the bony vertebral body epiphyses. (Bergknut et al., 2012, 2020; Spitzbarth et al., 2020).

The outer layers of AF have limited blood supply and there's no direct blood supply to the inner layers of the AF or to the NP. The branches of the vertebral epiphyseal arteries provide a vascular network next to the EPs. Nerve endings are sparse in the IVD itself – they've been

found only in the outer lamellae of the AF. The EPs supply the IVD nutrients such as oxygen and glucose through diffusion and osmosis. Additional nutrients are supplied by outer parts of the AF. Albumin, a large molecule, and enzymes, are transported by bulk fluid flow (Bergknut et al., 2020).

1.1.3. Pathophysiology

Degeneration of the canine intervertebral disc (IVD) occurs in both chondrodystrophic and non-chondrodystrophic breeds, displaying similarities to the degeneration observed in human IVDs. This process involves a cell-mediated response to the progressive structural failure of the disc, influenced by factors such as genetic predisposition, chronic physiomechanical stress, trauma, insufficient transport of metabolites and nutrients to and from the cells within the IVD matrix, altered enzyme activity levels, and changes in water content. One of the main reasons for the degeneration of the IVD is because of the avascular and low cellular nature of the IVD, leading to impairment of the ability of adequate repairment of the IVD matrix. The damage continues in a cycle of inadequate repair and not healing – leading to structural failure of the IVD and again may result in herniation of the IVD (Bergknut et al., 2012).

Intervertebral disc (IVD) degeneration progresses through five stages, ranging from a healthy IVD (grade I), represented in the Figure 1, to a severely degenerated IVD (grade V). The process begins with changes in the nucleus pulposus (NP), which changes from a shiny, translucent appearance to a dull, gray, non-translucent color. As degeneration advances, the NP collapses, and cleft formation occurs. The lamellar structure of the annulus fibrosus (AF) becomes disorganized, eventually making it difficult to distinguish the AF from the NP. In later stages, the intervertebral disc space narrows and may completely disappear, often accompanied by bulging of the degenerated AF or rupture of the AF with herniation of the NP (Bergknut et al., 2012).

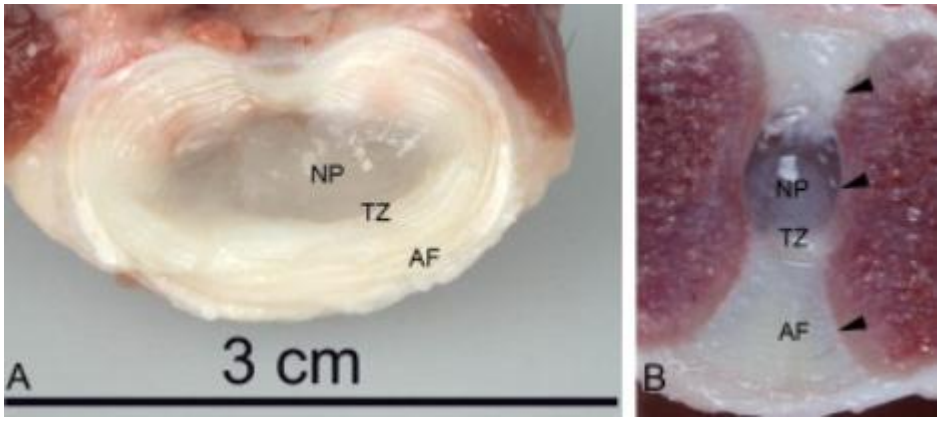

Figure 1. Transverse (A) and sagittal (B) sections through a L5–L6 intervertebral disc of a mature non-chondrodystrophic dog, representing the nucleus pulposus (NP), transition zone (TZ), annulus fibrosus (AF), and endplates (arrowheads) (Bergknut et al., 2013).

1.2. Genetic mechanisms

Genetic factor for predisposition for the skeletal dysplasia and intervertebral disc extrusion is the fibroblast growth factor 4 (FGF4) retrogene on chromosome 12 (CFA12). These mutations lead to the nucleus pulposus being replaced by hyaline cartilage which leads to premature degeneration of the IVD and calcification. In dachshunds it has been shown that even with acute disc herniations, most of the extruded disc material is calcified in histopathological examination (Murphy et al., 2019; Spitzbarth et al., 2020; Embersics et al., 2023).

In a study conducted by Rhodin et al., (2010), it was shown shown that 46–48% of intervertebral discs in Dachshunds display calcification, which is a hallmark of severe disc degeneration. In chondrodystrophic breeds, chondroid metaplasia - a pathological change where the nucleus pulposus of the IVD turns into cartilage-like tissue - begins early in life and progresses to mineralization.

Dachshunds also carry the retrogene FGF4 on chromosome 18, which is associated with extremely short limbs (Fenn et al., 2020). The FGF4 retrogenes is demonstrated to insert on chromosomes 12 and 18. The retrogene on chromosome 18 is linked with short-legged phenotype whereas on chromosome 12, there has been shown a link with age of onset and an overall risk of developing IVDD. The frequency of the FGF4 retrogene on chromosome 12 in the dachshund has been reported to be 0.97 (Thatcher et al., 2023). Despite the presence of disc degeneration in nearly all Dachshunds, not all develop clinically significant disc extrusions.

Histological data supports the concept that IVDD is multifactorial, with genetic, anatomical, and mechanical influences determining disease progression. (Rhodin et al., 2010).

Bergknut's study (2012) supports the need for screening DNA markers of IVD degeneration in order to prevent the inheriting of the IVDD genes in breeding programs.

1.3. Clinical presentation

The clinical signs of a canine IVDE patient depends on the localization of a lesion and vary between mild discomfort to paralysis without deep pain sensation. A typical clinical presentation of IVDE is an acute onset, pain and progressive myelopathy (Fenn et al., 2020). The clinical presentation of intervertebral disc extrusion in dogs varies from pain to severe spinal cord injury. Clinicals signs may be lameness, loss of sensory and motor functions caudal to the lesion, and incoordination caused by nerve root compression (Bersan et al., 2015; Spitzbarth et al., 2020).

Classification of the clinical signs can be represented on a scale from grade 0 to 5 (modified Frankel scale). Grade 0 is referred to normal. Grade 1 is pain and discomfort; grade 2 is ambulatory paraparesis/tetraparesis and ataxia, and proprioceptive deficits; grade 3 is nonambulatory paraparesis/tetraparesis; grade 4 is paraplegia/tetraplegia with deep pain perception and grade 5 is paraplegia/tetraplegia without deep pain perception (Fadda et al., 2013; Kranenburg et al., 2013).

1.4. Diagnostic imaging

Radiographs are still being used to diagnose IVDD in some clinics. Mineralized disc material in the vertebral canal could be noticed in the radiographs, if there is a significant IVD calcification present. Typically, the radiographs have presented a sensitivity range of only 51 to 61% (Olby et al., 2020). Initially, radiographs were used to diagnose intervertebral disc disease (IVDD). Later, myelography became a common diagnostic method. This procedure involves injecting a radiopaque contrast agent into the subarachnoid space prior to taking radiographs (Olby et al., 2020; Farré et al., 2024). Only in the 2000s onward, MRI and CT have been routinely used in animal hospitals (da Costa et al., 2020).

In a study conducted by Rohdin et al. (2010) it was found that the degeneration of the disc can lead to calcification of the disc, reported to be present in almost half (46-48 %) of their study population (n = 95) Dachshunds. Only part of the calcifications present in histopathology were able to be visualized on radiographic examination. They also demonstrated that only 20-40% of the calcified discs can be detected with radiography. They also stated that radiographic calcification peaks in Dachshunds between 3 to 5 years of age, while older dogs (8+ years) show fewer visible calcifications—likely due to extrusion, phagocytosis, or maturation-related changes. Moreover, Rhodin et al., (2010) showed that radiographic findings do not always correlate with clinical signs. In their study of 100 disc extrusions in 95 Dachshunds, 46% of the surgically confirmed extruded discs showed no calcification on radiographs.

Computed tomography can be used either without contrast, intravenous contrast, or CT myelography. In case of an acute IVDE, there can be noticed hyperattenuating material within the vertebral canal, loss of epidural fat and displacement of the spinal cord. Sensitivity for non-contrast CT is around 81,8% according to Olby (2020).

Magnetic resonance imaging is one of the most common diagnostic imaging methods used for examination of spinal problems in dogs and cats in modern days. Soft tissues, such as ligaments, synovial joints, nerve roots, spinal cord parenchyma, epidural fat, meninges, and IVD can be visualized and evaluated. The diagnostic sensitivity is high: >98,5%. Disadvantages are long duration of time, availability, and high cost (Olby et al., 2020; 2022).

Sequences used mostly in MRI imaging of IVDE are T1W, T2W and STIR. In T1W spinal fluid is seen as hypointense, in T2W as hyperintense, and lastly STIR is fat suppressing sequence. T1W images show extradural compression as hypointense from soft tissue and hemorrhage, used to identify the site of IVDE. These changes within the epidural space are represented in the Figure 2. T2W images are used to highlight cerebrospinal fluid. Low-field (0,2-0,4 T) units are widely used compared to the high-field (1,0-3,0 T) ones. At minimum T2W sagittal and transverse images are to be acquired (Olby et al., 2020; 2022; Khan et al., 2022).

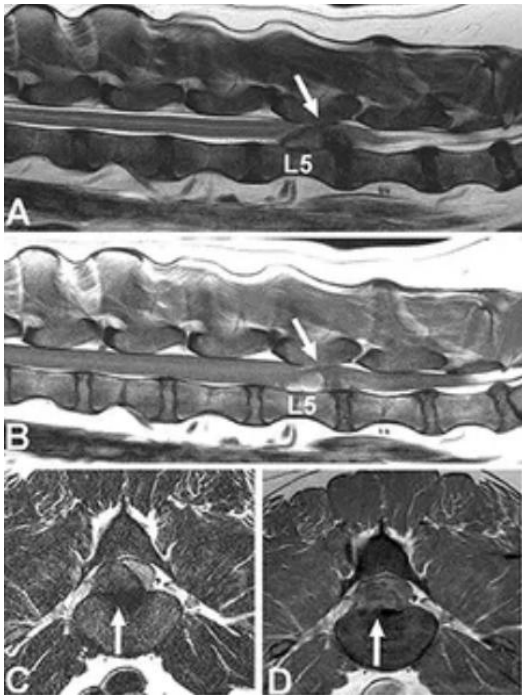

Figure 2. A representation of an extruded intervertebral disc with hemorrhage on a dog. **(A)** Sagittal T2W image showing a large mass with mixed signal intensity (arrow). **(B)** Sagittal T1W image showing that the cranial aspect of the mass is hyperintense (arrow). **(C)** Transverse T2 image showing severe spinal cord compression caused by a large hypointense mass (arrow). **(D)** Transverse T1W contrast-enhanced image showing mild heterogeneous contrast enhancement of the hypointense lesion (Da Costa et al., 2020).

1.5. Histopathology

The diagnosis is finalized with surgery and with histopathology. Localization is based on the clinical exam, then is confirmed localization and lateralization with diagnostic imaging, and operation is done according to that information. Surgery is the last confirmation (Kranenburg, 2012).

If the trauma is severe, secondary injury such as necrosis of the spinal cord and glial scarring can be found with neuroparenchymal cavitation and cyst formation. The histopathology of acute intervertebral disc extrusions in Dachshunds shows that the majority of the extruded disc material is calcified even without radiographically visible calcification (Spitzbarth et al., 2020).

Kranenburg (2012) demonstrated in their study that the histology of the IVDH type 1 reveals an inflammatory reaction triggered by disc material herniating into the spinal canal.

Inflammatory cells such as neutrophils and macrophages can be found. Swelling and inflammation are speculated to cause the compression of the dura mater. In case of damage on the dura, inflammatory mediators affect directly the spinal cord. Type 2 IVDH, blood vessels enter the periphery of the disc, leading to inflammatory changes on the AF. On the type 2 histology there can be seen lymphocytes, plasma cells, and macrophages, and granulation tissue, which indicate a chronic inflammatory response with tissue repair.

1.6. Prognosis

The severity of central nervous system injury is challenging to measure, and the outcome is hard to predict. Some injuries cause permanent neuron death, while others temporarily stop neurons from working allowing recovery later. Dogs with partial injuries and preserved sensation usually recover well, but dogs with complete injuries (paraplegia without deep pain sensation) have only a 50-60% chance of recovery. Paraplegic dogs with deep pain perception recover with conservative treatment 56% and with surgery 93%, whereas paraplegic patients without deep pain perception, only 22.4% recover with conservative treatment and 61% recover with surgery according to Olby et al. (2019, 2020).

Prognosis is good in subacute cases and less favourable in chronic cases. The most important prognostic considerations are recovery of ambulation, return to urinary and fecal continence and resolution of pain. A major factor affecting the prognosis is the loss of deep pain perception signals which worsens the outcome. There hasn’t been a study showing effect of the breed on prognosis (Olby et al., 2020).

The prognosis in animals with intact deep pain perception (grade 0-4) is considered to be good to excellent according to Olby et al. (2022). Ambulatory paraparetic dogs recover overall with conservative treatment 72.5% and with surgery 98.4%. Non-ambulatory paraparetic dogs recover with conservative treatment 79.8% and with surgery 93%.

With dogs having intact DPP, the prognosis on gaining ambulation ranges from 2 to 12 weeks. Despite the ambulation, there still may be incontinence. Spinal walking is reported often to be developed in deep pain negative dogs from physiotherapy. These dogs still don’t regain pain perception (Moore et al., 2020).

1.7. Treatment

The treatment options for canine IVDE are conservative therapy or surgical decompression of the spinal cord, meaning removal of herniated material from the vertebral canal (Moore et al., 2020).

1.7.1. Conservative treatment

Conservative treatment with movement restriction is suggested in case of a patient grade 1 or grade 2. In conservative treatment, strict activity restriction or cage rest is essential for prevention of further injury and in reducing the pain and inflammation of nerve roots. Duration of the rest is recommended to be for at least 4 weeks but 6-8 weeks has been found to be more efficient. Urinary bladder function should be maintained, either by manual emptying or catheterization. Physiotherapy plays a large role in both conservative and surgical treatment of IVDE. Physiotherapy is a controlled form of activity which is beneficial for locomotor recovery. The aim is to regain locomotion, movement, balance, and muscle mass. Restoration of movement is reported to be obtained the best from using under-water treadmill. Other forms of physiotherapy are for example massage and assisted standing and walking. Physiotherapy can safely be started as soon as 24 hours postoperatively without increased pain and should be continued for at least 2 to 6 weeks (Moore et al., 2020; Olby et al., 2022).

As for medications, analgesics and anti-inflammatory medications and analgesics are prescribed. Often COX-2-inhibitors are a preferred choice of NSAID for 7 days, accompanied with a calcium channel blocker for easing the neuropathic pain every 8 to 12 hours, commonly gabapentin. A good add to the pain relieving is an opioid, commonly a fentanyl patch for 3 to 5 days. Also, muscle relaxants can be used in the medical treatment of IVDE patients. Adverse effects are gastrointestinal mucosal lesions from high doses of NSAIDs but they often are subclinical (Fingeroth et al., 2014; Moore et al., 2020; Olby et al., 2022).

1.7.2. Surgical treatment

Surgical approach always is adjusted to location of extruded material. As stated by Moore (2020), surgical decompression is recommended in case of dogs who are non-ambulatory

paraparetic or worse because of IVDE, meaning grade 2 or worse in the scaling system. The decompression is suggested to be performed within 12 to 48 hours of the onset of neurological signs. It has been shown that the prognosis worsens with longer time to perform the surgical decompression (Moore et al., 2020).

Hemilaminectomy consists of removing half of the vertebral arch and lamina, pedicle, and articular process. Advantages are improved access to ventral portion of the spinal canal for removal of disc, and improved access for fenestration (Moore et al., 2020). This surgical approach is not used nowadays as mini-hemilaminectomy is found to be less invasive.

In minihemilaminectomy, the articular process of the vertebra is spared. The spinal canal is accessed via a small window from removing the lamina of the vertebra. The extruded disc material is removed from spinal canal, ensuring decompression of the spinal cord. An advantage is mentioned in Brisson et al. (2023) publication: minihemilaminectomy can be performed bilaterally without compromise to the bony support or soft tissues and that hemorrhage is typically easily controlled. Minihemilaminectomy allows a small incision with minimal bone removal (Tanaka et al., 2013).

1.7.3. Complications of surgery

Dogs undergoing spinal surgeries rarely have complications causing death. In a study made by Gouveia et al. (2024), intraoperative complications were reported in over 40% of the studied cases. These included hypothermia, hypotension, hemorrhage, regurgitation, hypoventilation, and bradycardia. A possible risk intraoperatively as stated by Olby et al. (2020) is the extrusion of an additional disc into the vertebral canal at the site of extrusion (Taylor-Brown et al., 2015; Moore et al., 2020; Olby et al., 2020).

Short postoperative (1-2 weeks) complications include bleeding, wound infection, healing issues, and early post-operative neurological deterioration with prolonged recumbency after surgery. Development of an abscess postoperatively has been reported. One of the most challenging complications is loss of voluntary urination and incontinence, possibly leading to urethral or bladder damage, and infections of the urinary tract. Postoperative complications include also hematoma or seroma formations at the surgical site (Olby et al., 2020; Gouveia et al., 2024). Also, additionally there have been reported postoperative changes such as flaccidity

of the abdominal wall (loss of muscle tone and unilateral or bilateral abdominal bulging), and worsening of the neurological condition (Shwab et al., 2023).

Late postoperative (>2 weeks) complications could be signs of systemic or surgical wound infection, adverse reactions to the surgical thread, deformities, and worsening of the neurological status as presented in a study by Shwab et al. (2023).

2. AIM OF THESIS

The aims covered in this thesis were as follows:

- To describe the distribution of intervertebral disc extrusion characteristics in dogs treated in Aisti Animal Hospital from September to October in 2024
- Identify the most commonly occurring findings of IVDE in dogs found in the physical examination, clinical diagnostic imaging, treatment, and outcomes in dogs presented in Aisti Animal Hospital

3. MATERIALS AND METHODS

The study included dogs admitted to Aisti Animal Hospital and diagnosed with an intervertebral disc extrusion. The data was collected from Aisti Animal Hospital's database Provet Cloud and handled with Microsoft Excel. Clinical records are gathered from September to October in 2024 with an overview of all the minihemilaminectomies performed in 2024 in Aisti Animal Hospital. All the study group dogs (n = 55) went through magnetic resonance imaging (MRI) and were diagnosed with an intervertebral disc extrusion. On both T1 and T2 weighted MRI images, the extruded disc material was identified by its low signal intensity within the epidural space. The study group was limited to the IVDEs localized between thoracic and sacral vertebrae (T3-S3). The following patient data information were collected: breed, age, sex, clinical symptoms, localization of the disc and treatment. This study included 55 patients in total, out of which three cases were described in detail in the case series.

Upon admission, the patient's clinical history was collected, breed, age, sex, and details of any incident, and prior medications. Then a comprehensive clinical assessment was performed, including a general physical exam, with orthopedic and neurological evaluations. Key observations included the patient's mental status, behavior, posture, and gait. Cranial nerve function and postural reactions were assessed, followed by examination of spinal reflexes. In cases of plegia – complete loss of voluntary movement – deep pain sensation was tested. Pain and signs of muscle atrophy were also evaluated. Based on disease course and clinical signs, differential diagnoses in spinal patients can include vascular, infectious/inflammatory, traumatic, neoplastic or degenerative diseases.

The surgical treatment method performed for IVDE patients was minihemilaminectomy. The disc material is removed from the spinal canal and then a preventive fenestration is done on the vertebra on the side of the extrusion. Patients received preoperatively cefazolin as an antimicrobial treatment and amoxicillin and clavulanic acid postoperatively. Postoperatively at home, the surgical patients received the same analgesic treatments and plans as the conservatively treated dogs.

The conservative treatment commonly consisted of an NSAID and gabapentin as medical treatment. Most often used NSAIDs were carprofen, meloxicam, and COX-2-inhibitors. Also, paracetamol was prescribed as extra pain killer in some cases. If the patient was very painful or underwent surgery, a fentanyl patch was put on the patient. Gabapentin was prescribed as a

4–8-week course with a lowering dosage. The other main part of the conservative treatment was restriction of movement, for 1-4 weeks. This meant no jumping, walking the stairs, and playing with other dogs and children. Walks were done shortly on a leash. Lastly, physiotherapy and bladder function observation play an important role in the recovery process.

This study was conducted in accordance with ethical guidelines and the privacy of individuals was maintained. The data collected from patients was handled anonymously. Each owner of the patients presented in patients case descriptions gave consent for the anonymous use of patient information in this study.

4. RESULTS

4.1. Distribution of the dogs with IVDE

In this retrospective study a total of 55 dogs with diagnosed and treated IVDD were included, covering time period of September-October 2024. From the data was analysed the distribution of neurological signs, the distribution of localizations, the distribution of treatments, and the distributions of age and sex.

During the whole year 2024, a total of 265 dogs were treated with minihemilaminectomy at Animal Hospital Aisti, as presented below in Figure 3. Out of 265 dogs, the most prevalent dog breeds were Dachshunds (including short, rough and longhaired Daschshunds and miniature Dachshunds), Corgis (including Welsh Corgi Pembroke and Welsh Corgi Cardican) and Coton de Tulear. In the results obtained, Dachshunds presented almost half of the minihemilaminectomies, being 38% (n = 100) of all minihemilaminectomies. Corgis presented 9% (n = 23) and Coton de Tulears presented 8% (n = 20) of all the minihemilactomies (n = 265).

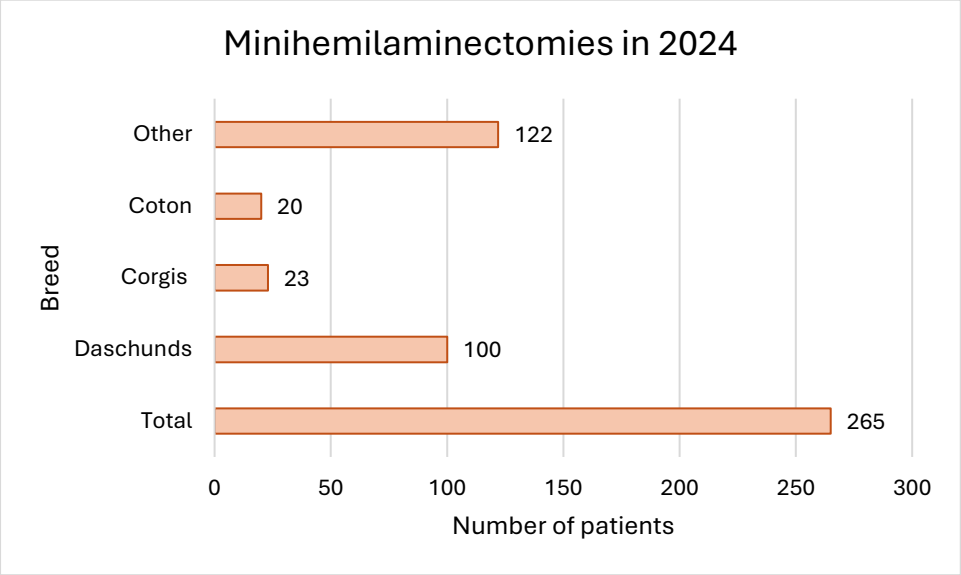

Figure 3. Illustration of the most prevalent breeds of dogs which underwent minihemilaminectomy surgical treatment in Animal Hospital Aisti during the year of 2024. In total 265 dogs with intervertebral disc extrusions were treated with minihemilaminectomy.

The age distribution presented in the Figure 4. did not present a major difference, and the ages were quite equally distributed. Most of the dogs (n = 11) were 4 years old at the presentation time. The mean age was 6.4 years old, ranging from 2 to 14 years.

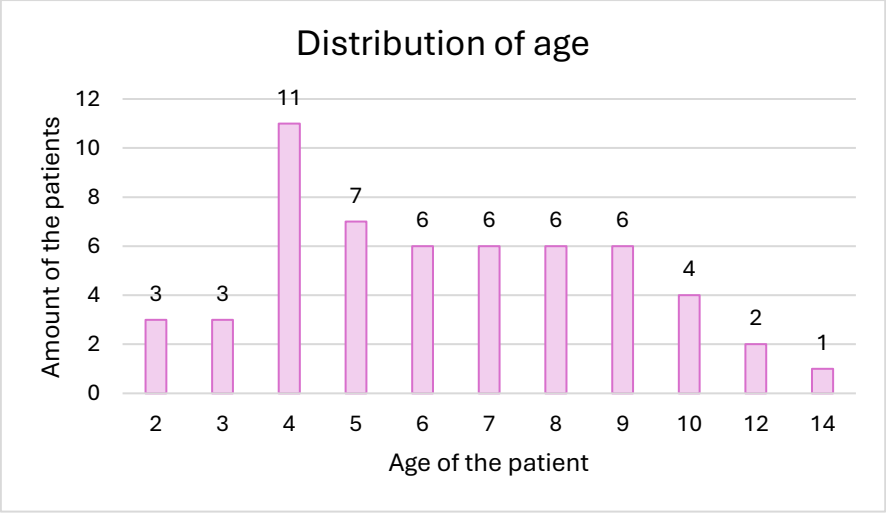

Figure 4. The distribution of age of the study population (n = 55).

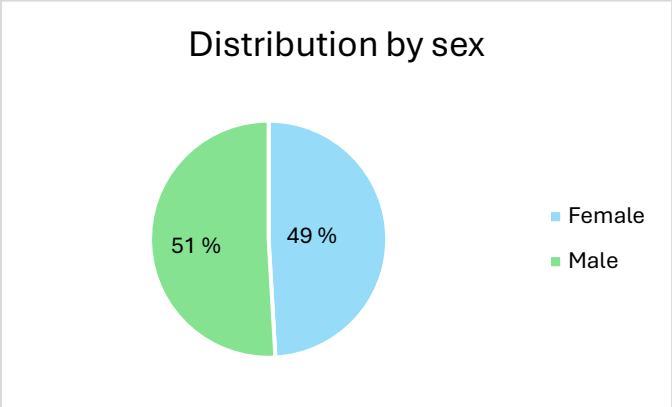

Figure 5. The distribution of patients (n = 55) by sex. Females included spayed and intact bitches and males included castrated and intact male dogs.

Figure 6 displays the distribution of neuroanatomical localizations identified in the study. The most frequently affected site was between vertebrae T12 and T13 (n = 15). This was followed by T13-L1 (n = 10) and T11-12 (n = 7) as the next most common regions. Another notable site was L1-2, with six cases. Other locations – including L2-3, L3-4, L5-6, T10-11, and various others – were each found in four or fewer dogs ($n \leq 4$).

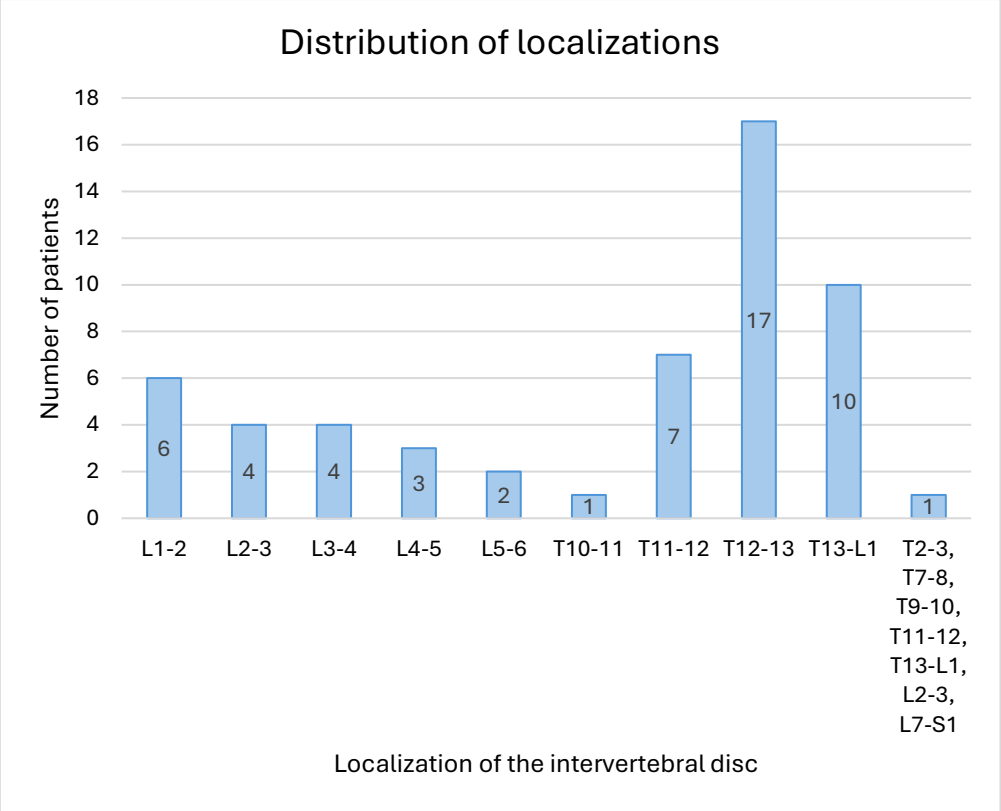

Figure 6. The distribution of localizations obtained from the magnetic resonance imaging (n = 55).

Figure 7. shows the breed distribution of dogs diagnosed with IVDE, highlighting how there was variation among the dog breeds. Dachshunds were the most frequently affected dog breed, making up 42% of the cases (n = 23). The second most common breed was mixed breed dogs (n = 8), Corgis (n = 7) and Papillon (n = 3). Other dog breeds presented in this study included Coton de Tulear (n = 2), Labrador Retriever (n = 2), Basset Hound (n = 2), Yorkshire Terrier (n = 1), miniature poodle (n = 1), Novascotian Duck Tolling Retriever (n=1), Boerboel (n = 1), English Springer Spaniel (n=1), Griffon Belge (n = 1), Chinese Crested Dog (n = 1), and Swedish Elkhound (n = 1).

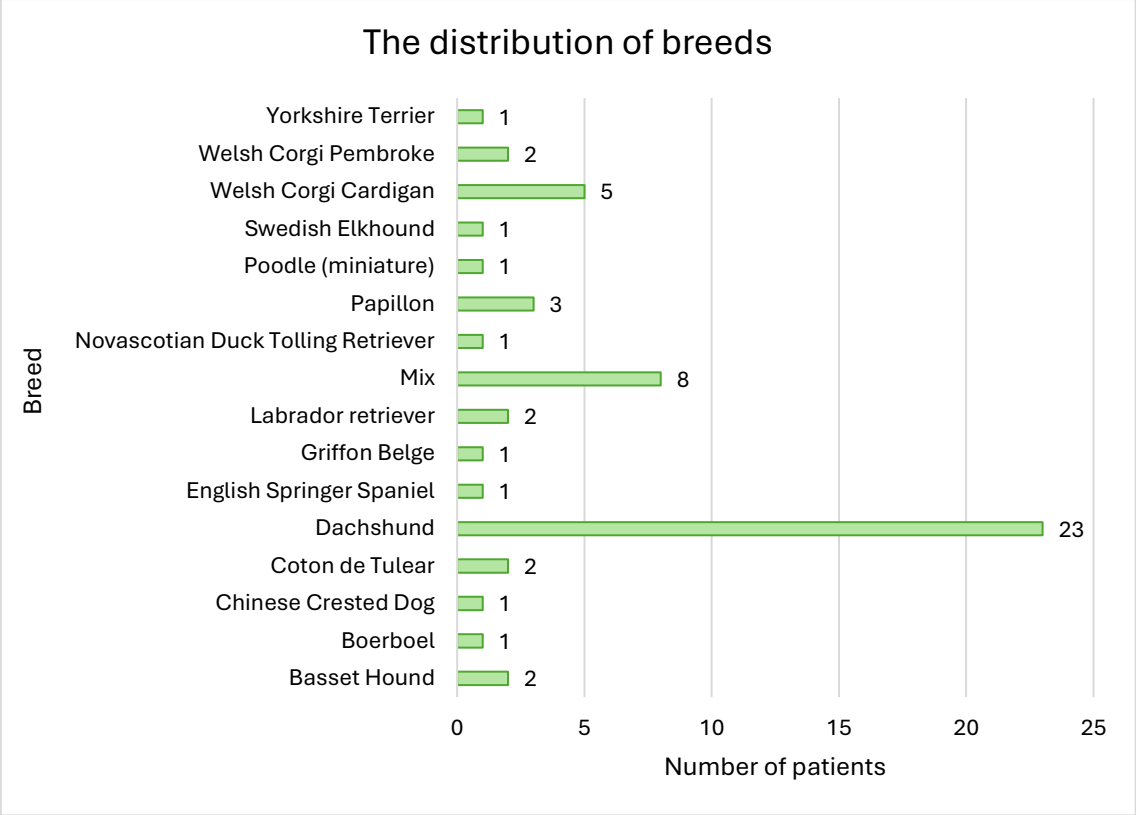

Figure 7. The distribution of different breeds of the patients (n = 55).

4.2. Clinical signs

The main neurological signs presented in the patients is illustrated in Figure 8. These were ataxia, pain, paraparesis, paraplegia, proprioceptive deficits, and tetraparesis. More than half (56%) of the dogs were paraparetic and 31% of the dogs were paraplegic. The remaining 13% of the patients had only proprioceptive deficits (5%), pain (4%), or ataxia (2%) without paraparesis or paraplegia. Tetraparesis was observed in just one dog, accounting for 2% of the total. This dog had multiple IVDEs.

Most common neurologic sign in the IVDE patients was to be found paraparesis. Paraparesis was often presented with ataxia and pain in the neurological examination. Spinal reflexes were usually normal as well as cranial nerves. The proprioceptive positionings were commonly impaired in the paraparetic IVDE dogs and completely missing in paraplegic IVDE dogs. The mental status was normal in typical IVDE patients.

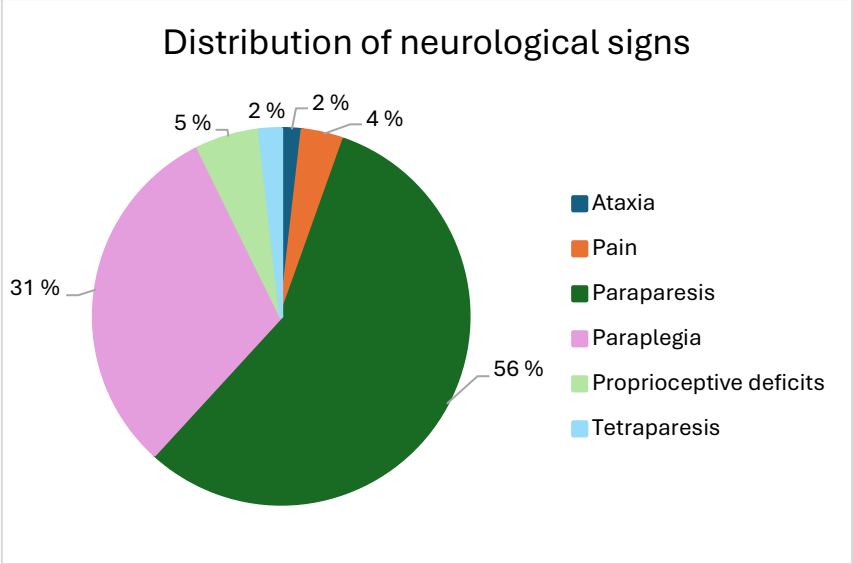

Figure 8. The distribution of neurological signs presented in the patients (n = 55).

4.3. Treatments

The treatments had a clear distribution. The results are presented in the Figure 9. Most of the dogs were treated surgically with minihemilaminectomy (62%) while a smaller portion, 32%, were treated conservatively. The remaining 6% of dogs were euthanized because their condition and diagnosis offered no hope in recovery. In one particular case, the dog was suspected to have myelomalacia which could not be treated.

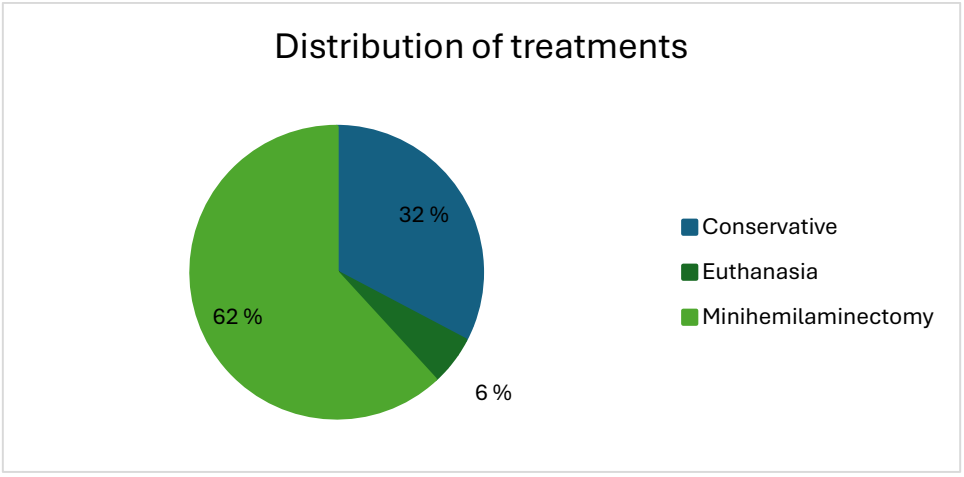

Figure 9. The distribution of treatments among the diagnosed patients in the study (n = 55).

4.4. Case descriptions

4.4.1. Case 1

Signalment and history

A four-year-old female Short-Haired Miniature Dachshund was presented at the emergency care unit for difficulty and stiffness in movement, back pain, dragging her legs and wobbly hind limbs. One year ago, she was diagnosed with bilateral patellar luxation. Otherwise, she did not present other abnormalities.

Neurological examination

At the clinic the emergency veterinarian diagnosed her with ataxia and decreased proprioceptive responses in hindlimbs, ambulatory paraparesis, and pain in thoracic spine. The patient received an opioid analgesic during the night. In the morning in the neurological examination, she was diagnosed with severe paraplegia without deep pain sensation (grade 5/5) and decreased spinal reflexes in the hind limbs and tail. Front limbs and cranial nerves were found to be normal. Localization was suspected to be thoracic-lumbar spinal cord T3-S3.

Diagnostic imaging

In the magnetic resonance imaging, there was found an extradural spinal cord compression ventrally to the right between T11-12.

Treatment

This patient was treated surgically with minihemilaminectomy for removal of the extruded disc material from the spinal canal. After, the preventive method, fenestration, was done from the right of T11-12. The spinal cord had been visually normal. Postoperative care at home consisted of an antimicrobial treatment course (amoxicillin and clavulanic acid, 24 mg/kg BID) for five days. As for analgesia, a fentanyl patch was put on the patient for 3-4 days and a COX-2-inhibitor was prescribed once a day for 7-10 days. Movement restriction was mandatory for four weeks with physiotherapy. The bladder function was to be monitored carefully at home.

Treatment outcome

Two and half months after the surgery, this patient came for control visit as the progression of recovery had slowed down according to the owner. The patient had otherwise been doing well and eating normally. She also managed to urinate and defecate without complications.

Physiotherapy had been started. In the control visit's clinical examination was found that the patient presented ambulatory paraparesis (degree 3/5) and missing proprioceptive responses in the hindlimbs. Muscle atrophy was found in the hind limbs and back muscles. Front limbs and cranial nerves were normal. She was prescribed to only continue physiotherapy as the recovery had progressed from the preoperative condition. The recovery could in a case this severe (paraplegia 5/5) take even eight months.

Half a year later the patient had recovered well and has been able to walk herself without support. The left hind limb still might present some paresis some days according to the owner. The patient has monthly physiotherapy visits nowadays. Postoperatively the physiotherapy visits were more frequent. The patient is urinating and defecating normally, except there has been unregular incontinence. The urinating has been more frequent after the surgical treatment. Also, according to the owner, from time to time, the patient might present weakness of the hindlimbs while eating. There has not been a need for analgesics after the recovery from the surgery.

4.4.2. Case 2

Signalment and history

A five-year-old female Longhaired Dachshund was presented at the emergency care because hind limbs have not worked normally and were wobbly, according to the owner. There had always been reluctance to jump. No other previous medical conditions.

Neurological examination

In the emergency veterinarian's clinical examination the patient represented with ataxia of hindlimbs, paraparesis, pain in the palpation of thoracic spine and decreased proprioceptive response in the left hind limb. The patient received opioid analgesics during the night.

In the morning in the neurological examination the patient presented ambulatory paraparesis and mild ataxia. Mildly decreased proprioceptive responses in the hind limbs, and normal cranial nerves and spinal reflexes, no pain in palpation of the spine. Neuroanatomical localisation was T3-L3 spinal cord.

Diagnostic imaging

The patients was further diagnosed with MRI which revealed an extradural compression ventrally T12-13 with hyperintense changes cranially T11-12 and caudally T13-L1.

Treatment

Minihemilaminectomy was performed and the fenestration was done from the left T12-13, and the extruded disc material was removed. The spinal cord was visually normal. Postoperatively antimicrobial treatment course (amoxicillin and clavulanic acid, 19 mg/kg BID) of five days was prescribed. For analgesia the patient was prescribed a coxib, a fentanyl patch and a course of gabapentin. Gabapentin was prescribed 9.4 mg/kg twice a day for three weeks, then 4,7 mg/kg twice a day for one week and then 4.7 mg/kg once a day for one week. Four weeks of movement restriction with physiotherapy was instructed.

Treatment outcome

Lost of follow-up.

4.4.3. Case 3

Signalment and history

A six-year-old male Shorthaired Dachshund was presented at the emergency care for recurring paralysis symptoms. 5 months before the patient had been operated because of an IVDE at T13-L1. The patient had recovered from the surgery completely.

Neurological examination

The patient presented paraplegia with normal deep pain sensation (degree 4/5), normal spinal reflexes. Front limbs and cranial nerves were normal. Localisation was thoracic-lumbar spine T3-L3.

Diagnostic imaging

The MRI showed an extradural spinal cord compression from left at T12-13.

Treatment

The patient was treated surgically with minihemilaminectomy. The spinal cord was visually normal after the extruded disc material removal. Then preventive fenestration was done from the left T12-13. Postoperatively antimicrobial treatment course (amoxicillin and clavulanic acid, 20 mg/kg BID) of five days was prescribed. For analgesia the patient was prescribed an NSAID, and a fentanyl patch. Four weeks of movement restriction and physiotherapy were instructed.

Treatment outcome

The treatment outcome was obtained from the owner via a phone call half a year later from the surgery. The patient had recovered fairly well after the second surgery. The patient still represents at times paraparesis or weakness of the hindlimbs per the owner's statement. The walking had otherwise been normal. The owner stated that the winter had been more difficult for the recovery and the patient's back had been stiff. During the spring the patient had been moving better. Jumping had been avoided. The patient has regular physiotherapy sessions and had had four times a water treadmill session. The urinating and defecating had been normal, and the patient has not had any need for analgesics postoperatively after the recovery.

5. DISCUSSION

This retrospective case series study analysed data from 55 dogs whose patient data and clinical information was collected from the Animal Hospital Aisti. In the study there was included an overview of all the minihemiaminectomies performed in Aisti Animal Hospital during the year of 2024, for perspective and comparison. The collected data was based on the information written by the veterinarian in charge, and in the three detailed patient case reports were included follow-up phone calls about the recovery process.

This study highlighted the breed, neurological signs, and localisation distribution of IVDE dogs. Patients each underwent magnetic resonance imaging (MRI) for diagnosis, and only dogs with lesions between T3 and S3 vertebrae exactly were included. This approach allowed for a more focused evaluation in terms of hindlimb neurological deficits as well as without decreased reflexes. Cervical and also coccygeal IVDE cases were excluded for specificity.

Breed predisposition was found to be clearly evident in the results, with Dachshunds being the most commonly affected breed of the study, representing 42% of the study population (n = 55). This was found to be consistent with earlier literature, particularly studies by Fenn et al. (2020), highlighting the influence of genetic factors, such as the FGF4 retrogene on chromosome 12, that are prevalent mostly in chondrodystrophic breeds. While chondrodystrophic breeds were the mostly this study's population, the study also found a small presence of larger, non-chondrodystrophic dogs diagnosed with IVDE, such as Labrador Retrievers and Boerboels. Although these cases were few, their presence supports the notion that IVDE should remain a differential diagnosis with the classical neurological signs, even in breeds not traditionally associated with IVDD.

The clinical signs most commonly met were paraparesis and paraplegia, affecting a combined total of 87% of the dogs observed (n = 55). In a retrospective study ran by Immekeppel et al. in 2021, the numbers are again fairly similar, and the findings are in line with their larger data. In their study (n = 1501) was found that 63.5% of the patients were paraparetic and 17 % of the dogs were paraplegic. Paraparesis, often accompanied by proprioceptive deficits, was the most frequent presentation, reflecting partial loss of voluntary motor control in the hindlimbs. Paraplegia, characterized by complete loss of voluntary motor function, was observed in more severe cases. Cranial nerves and spinal reflexes remained largely intact. Pain, ataxia, and postural deficits were also frequently diagnosed during the neurological examinations.

The IVDE localisations were in this study (n = 55) found to be most frequently in T12-13 with 17 dogs, being 31% of all the study group. 62% of the localizations were T11-12, T12-13 and T13-L1, representing in total more than half of the study group, 34 dogs out of the 55. The next most frequent areas were in the lumbar region L1-2, L2-3, and L3-4, being altogether 14 patients, counting for 25% of the study group. In this study, only one dog (2%) had multiple intervertebral discs extruded whereas the rest had one disc extruded. This would indicate that in the majority of IVDE cases there is one extruded disc. It is still not excluded that there would be multiple extruded discs.

The surgical treatment was the most common treatment type in this study group, representing 62% of the dogs observed. As stated by Olby (2022), ambulatory dogs can be managed successfully conservatively but there is a risk of recurrence. She also mentions that non-ambulatory paraparetic or paraplegic deep pain-positive dogs can also be managed successfully conservatively but the success rates for recovery are likely to be improved with surgery and thus is recommended. In this study group too, a few recurring IVDE patients were met. Olby also mentioned in her publication with high-level evidence that paraplegic deep pain-negative dogs should be treated surgically for a better success.

The conservative treatment consisted of restriction of movement, analgesics, and physiotherapy. The most common movement restriction time mentioned in this study was for 4 weeks, as also mentioned in Olby's publication (2022). Physiotherapy emphasized as a crucial part of both postoperative and conservative management. Almost all the patients in this study were prescribed to physiotherapy. Only a small portion of patients (6%) in this study group were euthanized due to a poor prognosis or diagnosis.

The mean age was found to be in this study 6.4-years-old. A retrospective study (n = 1501) by Immekeppel et al., (2021) showed that 51.7% of the dogs were categorised in age group from four to seven years old. In this study group 54.5% (n = 55) of the dogs are a part of the same age group, which would support the hypothesis that dogs aged from four to seven years old would be more prone to IVDE. Although, this study's range of ages is reasonably wide, from 2-14 years, meaning that IVDE is not limited to a disease of dogs that are middle-aged but this can affect younger and older dogs as well.

Overall, the findings of this study are consistent with existing literature on canine IVDE and reinforce the critical role of advanced imaging and tailored treatment strategies in achieving successful outcomes. The individual clinical presentation, MRI findings, and severity of neurological deficits remain the most important factors guiding treatment. Surgical intervention continues to offer the best prognosis in most and more severe cases, but conservative management remains a valid and often successful approach in less severe, ambulatory patients. Recovery times varied depending on the severity of the condition and the chosen treatment, but most dogs demonstrated progressive improvement with appropriate care and follow-up. Despite some limitations, including the relatively small sample size and the retrospective nature of the study, the findings contribute valuable clinical insight into the presentation and management of IVDE in dogs.

The outcomes of the patients treated with surgical decompression were found to be positive, also in this study. Out of the 62% of the patients from this study that were treated with mini-hemilaminectomy, three were taken into the more detailed case descriptions. All of the operated dogs had recovered almost completely to normal during 6-month postoperative recovery period, according to the owners. The treatment outcomes were obtained from the owners with consent to use the patient data anonymously via follow-up phone calls. One of the three patients had had a setback during their recovery period.

6. CONCLUSIONS

The results of this study are consistent with existing literature, particularly regarding breed predisposition. Dachshunds made up the majority of the cases, which aligns with previous research linking chondrodystrophic breeds to a higher risk of IVDE. Across all cases, clinical histories, neurological findings, MRI results, and postoperative or conservative care protocols were largely similar. Both surgical and conservative treatments followed standardized guidelines, and the home care instructions showed minimal variation.

In summary, this study reinforces the established understanding that Dachshunds are disproportionately affected by IVDE and highlights the consistency in clinical presentation and management across similar cases. These findings contribute to the broader body of evidence supporting breed predisposition and standardized treatment pathways in the management of IVDE in dogs.

ACKNOWLEDGEMENTS

I would like to thank my supervisors Professor Toomas Orro and Aisti's neurologists Janis Jeserevics and Janis Baltkajs for their guidance and support during my final thesis work. I also want to thank Aisti Animal Hospital for providing the case material. My colleagues from Aisti and our university, and my family deserve a thank you as well for their support during my studies.

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APPENDICES

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