# Exploring Orthobiophysiatry and Honoring the Medical Legacy

# NEWSLETTER

**#8 – August 2025**

grupoandes
MEDICINA REGENERATIVA
Veterinaria

## Prologue:

### A Milestone in the Scientific Veterinary Journey

Dear colleagues, loyal readers, and passionate advocates for animal well-being,

It is with immense pleasure that we present to you the eighth issue of **"NewsLetter"** Since our launch in April 2023, with three editions annually, we have diligently cultivated this space with the firm purpose of being a platform for knowledge, innovation, and critical reflection in the field of veterinary medicine. This milestone not only marks our continuity but also reaffirms our commitment to scientific excellence and the constant pursuit of advancements that transform the lives of our patients.

In each edition, we have navigated the complexities of animal pathology, celebrating the diagnostic and therapeutic prowess forged over years of tradition. Simultaneously, we have opened our pages to the most cutting-edge methodologies that promise to redefine the limits of what is possible. This eighth issue perfectly encapsulates that duality we consider essential: **"Exploring Orthobiophysiatry and Honoring the Medical Legacy."**

On this occasion, we continue to underscore the indispensable importance of traditional medicine, that which grounds our understanding and guides our initial actions. The relevance of **precise diagnosis**, supported by conventional tools, is evident in research such as the study on the "Frequency of spinal column alterations in Dachshund breed canines." This type of analysis not only refines our ability to identify and manage prevalent conditions but also forms the foundation upon which any therapy, be it traditional or innovative, can be built.

At the same time, we look to the future with the same conviction. We delve into the promising waters of **regenerative medicine and orthobiophysiatry**, fields that open new avenues for healing and rehabilitation. The article exploring "Platelet-Rich Plasma as a Potential Regenerative Therapy in Canine Degenerative Myelopathy" is a testament to how science seeks bold solutions for previously untreatable diseases, offering hope and paving the way for personalized, "Point-of-Care" therapies. We recognize that these innovations are still under development, but their potential is undeniable and merits our rigorous attention.

From an editorial perspective, our vision remains clear: to foster an informed and evidence-based dialogue. We firmly believe that progress is achieved through scientific rigor, methodological transparency, and critical discussion. Therefore, every article and every section of this newsletter has been selected to inspire, educate, and provoke thought, always with the aim of elevating the standard of veterinary practice.

We hope that "NewsLetter" becomes an essential read in your routine, a valuable resource that fuels your curiosity, expands your knowledge, and empowers you to face the challenges of veterinary medicine with new tools and perspectives.

Welcome aboard this fascinating journey of discovery and evolution.

Sincerely,
The Editor

# TABLE OF CONTENTS



# 1. Frequency of Spinal Column alterations in dachshund breed canines diagnosed in a veterinary clinic located in Puerto Montt city 2019-2023 Chile

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**Abstract**

The Dachshund breed, particularly known as "sausage dog", stands out for its appearance of short limbs and an elongated torso. This dwarfism is associated with conditions called chondrodysplasia and chondrodystrophy, results of mutations at the level of the FGF4 retrogene, responsible for regulating bone development. While chondrodysplasia refers to a problem in bone development related to genetic mutations that affect bone length, chondrodystrophy is a degenerative cartilage condition that leads to joint problems and can involve problems in the spine.

In Chile, according to the national pet registry, for the year 2019 the Dachshund was positioned as the fifth most present breed in the country, holding first place among the breeds called chondrodystrophic and chondrodysplastic, which is why it was decided to focus this study on this particular breed.

Between the years 2019-2023, 245 Dachshund canines arrived at the "Terravet" veterinary clinic located in the city of Puerto Montt, Chile, showing signs suggestive of problems at the spinal column level. The canines were subjected to neurological examinations and at least three complementary examinations such as x-rays, myelograms, computed tomography, and magnetic resonance imaging in order to determine which particular pathology they had.

The results showed that 49% of the cases presented problems in the thoraco-lumbar segment of the spine. Intervertebral disc disease was the most common pathology, affecting 61% of the dogs studied. Furthermore, it was observed that 62% of the patients treated were males and 40% of the studied population were mature adult dogs. The diagnosed alterations were classified as traumatic or acquired, the latter being the most common, present in 76% of the patients.

**Keywords**: Dachshund, chondrodystrophic, chondrodysplastic, spine.

## Introduction

In the 18th century, hunting was one of the most common human activities, especially accompanied by a canine, among which the Dachshund, popularly known as "sausage dog" or Teckel, stands out. Its elongated and slender body provided enough size and power to face burrowing animals, along with its shortened limbs that allowed it to stay close to the ground and agile to scurry and get into small places, home to various target species like the badger, the animal from which the lineage name comes (1).

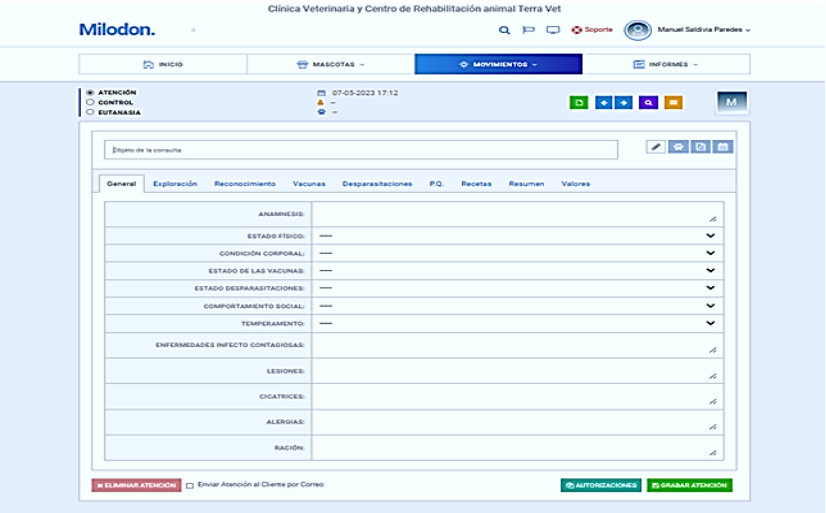
As part of the common Dachshund genome, we will find the combination of 2 FGF4 retrogenes (Fibroblast Growth Factor 4), causing the conditions called chondrodysplasia and chondrodystrophy, which together originate this disproportionate dwarfism characteristic of the breed (2). Nowadays, it has been shown that, thanks to these genetic modifications, this breed predisposes to a greater number of alterations, mainly at the level of the spinal column and adjacent structures (3).

There are an infinite number of alterations that are not possible to determine at first glance and that present similar symptomatology on physical examination, which is why the support of complementary examinations is required, mainly those capable of providing an image of the problem such as radiographs, ultrasounds, among others (4). In the present study, musculoskeletal lesions, disc diseases, joint lesions, malformations, neoplasms, and fractures were identified, and the most frequent to diagnose in Dachshund canines was determined by means of imaging techniques such as radiography, myelography, ultrasonography, computed tomography, and magnetic resonance imaging in a veterinary clinic in the city of Puerto Montt during the years 2019 to 2023, and its degree of association with the variables age, origin, segments, and anatomical structures involved was determined.

## Material and method

The research was carried out at the "Terravet" veterinary clinic and animal rehabilitation center, located in the city of Puerto Montt, Chile, with all records of Dachshund canines evaluated from January 2019 to October 2023. The study material corresponds to the records of 245 Dachshund canine patients attended at the "Terravet" veterinary clinic and animal rehabilitation center, regardless of sex, with age ranges between 4 months and 14 years, who presented signs compatible with neurological alterations of the spinal column by means of neurological evaluation and complementary examinations, from January 2019 to October 2023. The clinical records of the patients were attached through the Milodon® veterinary center management software, where the largest amount of information transmitted by the owner and the clinical findings of each patient were collected and verified (annex).

Annex: Patient data and history record.




For the neurological evaluation of each patient, a digitized form oriented to the determination of neurological conditions and spinal column neurolocalization was used.

Equipment located in "Terravet" veterinary clinic:

- Portable X-ray equipment EPX-3200 ®
- CR FireCR Spark 70 digitizer associated with QuantorVET ® software
- Mindray Z60 Vet ® ultrasound scanner

Complementary examinations performed outside the city of Puerto Montt:

- Evaluation results via magnetic resonance imaging.
- Evaluation results via computed tomography.

**Method** Records of 245 Dachshund canines were included in this study, which were neurologically evaluated and subjected to at least 3 complementary examinations such as radiography, myelography, computed tomography, and magnetic resonance imaging for the diagnosis of any type of spinal, osteological, or both alterations

Patients considered in this study included the presence of pain associated with the spinal column, partial or total loss of strength in thoracic or pelvic limbs or all of them, decreased size of muscle groups in the trunk and limbs, and that the clinical signs indicated by the owner were related to sporadic, accidental, or gradual events over time. Patients with systemic signs associated with cardiorespiratory, gastrointestinal, reproductive, and urogenital alterations were excluded.

According to the type of alteration to be detected, they were classified according to the affected spinal vertebral anatomical segment (cervical, cervico-thoracic, thoracic, thoraco-lumbar, lumbar, lumbosacral-coccígeal, or coccígeal), compromised anatomical structures (spinal column, spinal cord, musculature, arthrology, and/or meninges), and classification of the type of alterations with links associated with a traumatic or acquired condition.

**Results** Between the years 2019 to 2023, a total of 245 Dachshund canines were attended at the "Terravet" veterinary clinic and rehabilitation center for symptomatology compatible with some type of alteration at the spinal column level.

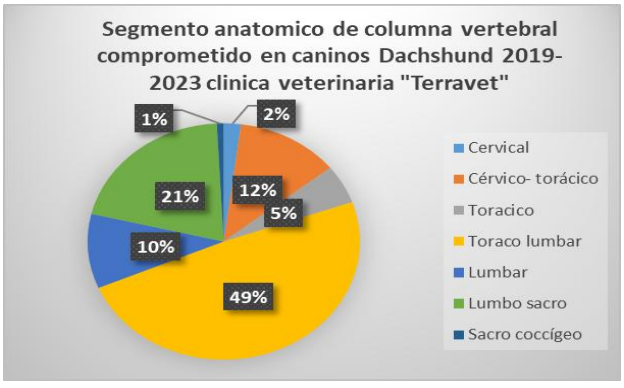
By means of general physical examination and neurological examination, it was possible to recognize in 49% of the cases involvement of the thoraco-lumbar segment, Table 1 and Figure 1.

Table 1. Frequency of compromised anatomical segment in records of spinal column alterations in Dachshund dogs diagnosed in a veterinary clinic between 2019-2023 in the city of Puerto Montt**.**

| *Anatomical Segment* | *Patient Record (fi)* | *FI* | *hi* | *%hi* |
|---|---|---|---|---|
| *Cervical* | 5 | 5 | 0,02 | 2 |
| *Cervico-thoracic* | 30 | 35 | 0,12 | 12 |
| *Thoracic* | 13 | 48 | 0,05 | 5 |
| *Thoraco-lumbar* | 120 | 168 | 0,49 | 49 |
| *Lumbar* | 25 | 193 | 0,1 | 10 |
| *Lumbosacral* | 50 | 243 | 0,21 | 21 |
| *Sacrococcygeal* | 2 | 245 | 0,01 | 1 |
| ***Total*** | 5 | 5 | 0,02 | 2 |

*Source: Own elaboration.*

Figure 1. Pie chart of compromised anatomical segment in records of spinal column alterations in Dachshund dogs diagnosed in a veterinary clinic between 2019-2023 in the city of Puerto Montt**.**




*Source: Own elaboration.*

The alterations of the patients were identified by complementary examinations such as simple and contrasted radiography, ultrasonography, computed tomography, and magnetic resonance imaging where it was possible to recognize more than one alteration in some cases. All patients presented musculoskeletal lesions in different degrees, being significant only in puppies, equivalent to 2% of total cases, and this mainly due to exposure to traumatic forces.

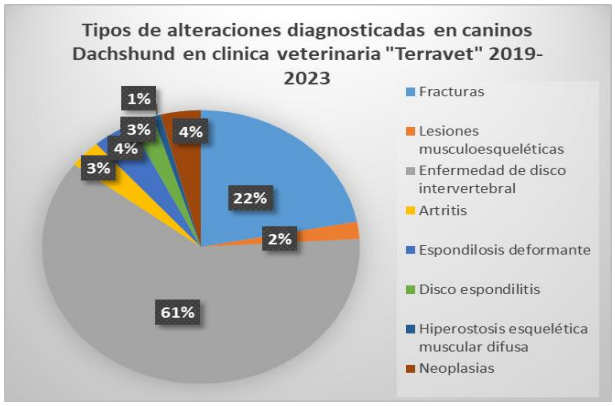
On the other hand, the pathology that affected 61% of the studied population, Table 2 and Figure 2, specifically 100% of young dogs, between 65-75% of mature adults, Figure 3 and 4 , between 40-55% of older dogs , Figure 5 and 6 and 40% of geriatric dogs , Figure 7 and 8 , was intervertebral disc disease.

Table 2. Frequency of type of spinal column alterations in Dachshund dogs diagnosed in a veterinary clinic between 2019-2023 in the city of Puerto Montt.

| Alterations | Patients | Fi | hi | %hi |
|---|---|---|---|---|
| Fractures | 54 | 54 | 0,22 | 22 |
| Musculoskeletal lesions | 5 | 59 | 0,02 | 2 |
| Intervertebral disc disease | 150 | 209 | 0,61 | 61 |
| Arthritis | 8 | 217 | 0,03 | 3 |
| Spondylosis deformans | 10 | 227 | 0,04 | 4 |
| Discospondylitis | 6 | 233 | 0,03 | 3 |
| Diffuse idiopathic skeletal hyperostosis | 2 | 235 | 0,01 | 1 |
| Neoplasia | 10 | 245 | 0,04 | 4 |
| **Total** | 245 | | 1 | 100 |

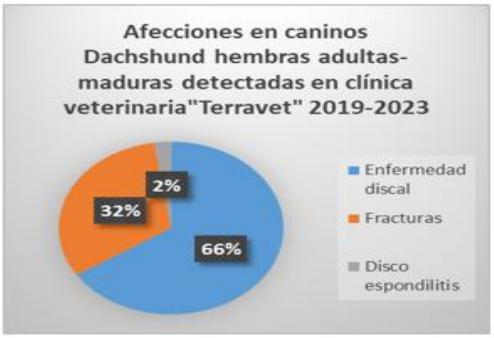
Source: Own elaboration

Figure 2. Pie chart of type of spinal column alterations in Dachshund dogs diagnosed in a veterinary clinic between 2019-2023 in the city of Puerto Montt.



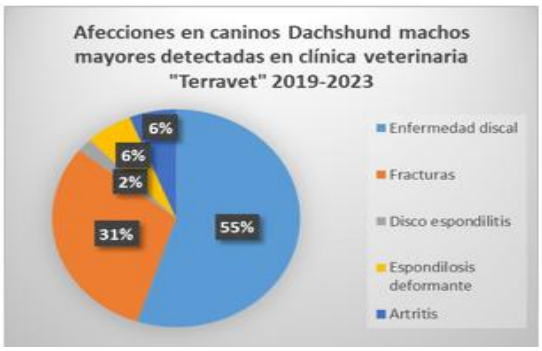

Source: Own elaboration.

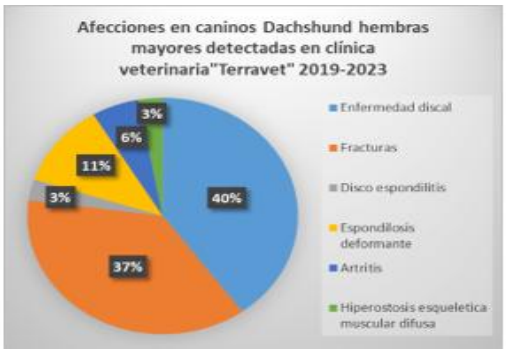
Figure 3 and Figure 4. Pie charts of types of spinal alterations present in male and female mature adult Dachshund dogs diagnosed in a veterinary clinic between 2019-2023 in the city of Puerto Montt.


Source: Own elaboration.

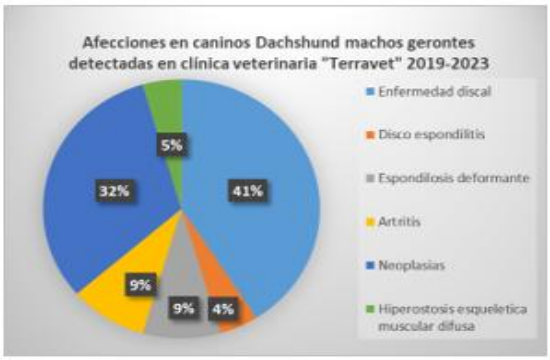
Figure 5 and Figure 6. Pie charts of types of spinal alterations present in older male and female Dachshund dogs diagnosed in a veterinary clinic between 2019-2023 in the city of Puerto Montt.

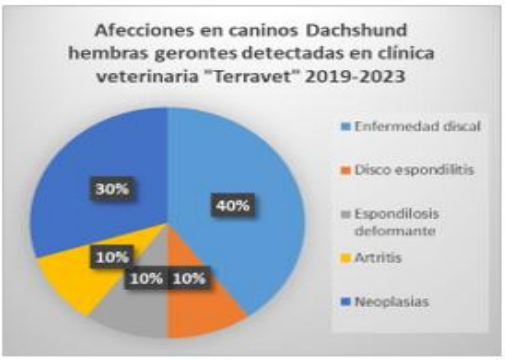



Source: Own elaboration.

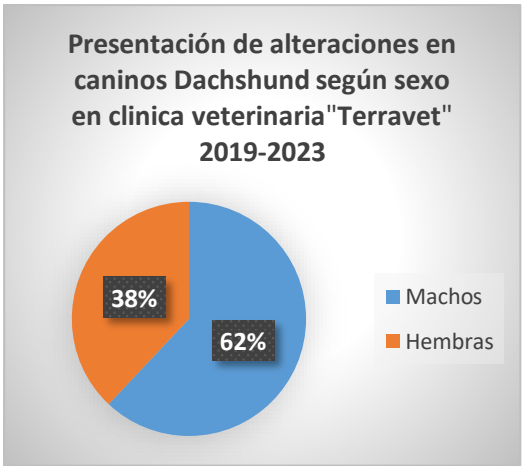
Figure 7 and Figure 8. Pie charts of types of spinal alterations present in male and female Dachshund dogs diagnosed in a veterinary clinic between 2019-2023 in the city of Puerto Montt.




Source: Own elaboration.

Figure 9. Pie chart of Dachshund patients attended at the veterinary clinic between 2019-2023 in the city of Puerto Montt by sex.




Source: Own elaboration.

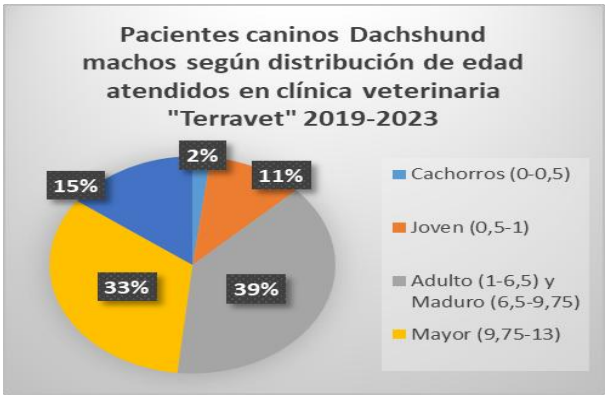
In both males and females, the age of highest presentation of alterations spans the adult-mature age range, corresponding to 40% of the studied population, Table 3 and 4, Figure 10 and 11.

Table 3. Frequency table of age distribution of male Dachshund dogs diagnosed with spinal column alterations in a veterinary clinic between 2019-2023 in the city of Puerto Montt.

| Age Group (age) | Patients | Fi | hi | %hi |
|---|---|---|---|---|
| Puppies (0-0.5 months) | 3 | 3 | 0,02 | 2 |
| Young (0.5 months to 1 year) | 16 | 19 | 0,11 | 11 |
| Adult (1-6.5 years) and mature adult (6.5-9.75 years) | 57 | 76 | 0,39 | 39 |
| Older (9.75-13 years) | 49 | 125 | 0,33 | 33 |
| Geriatric (over 13 years) | 22 | 147 | 0,15 | 15 |
| **Total** | 147 | | 1 | 100 |

Source: Own elaboration.

Figure 10. Pie chart of age distribution of male Dachshund dogs diagnosed with spinal column alterations in a veterinary clinic between 2019-2023 in the city of Puerto Montt.



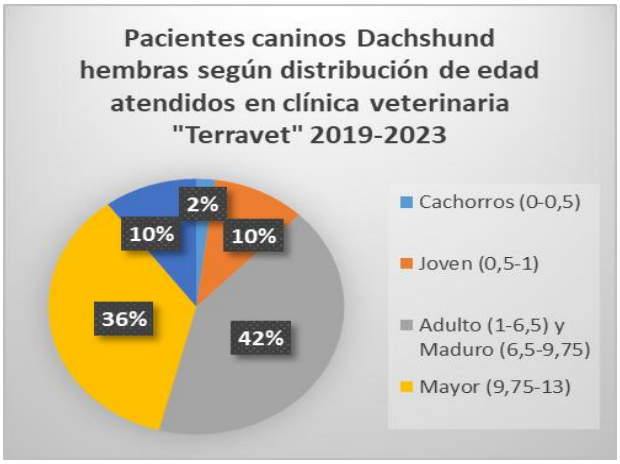

Source: Own elaboration.

Table 4. Frequency distribution of ages of female Dachshund dogs diagnosed with spinal column alterations in a veterinary clinic between 2019-2023 in the city of Puerto Montt.

| Age Group (age) | Patients | Fi | hi | %hi |
|---|---|---|---|---|
| Puppies (0-0.5 months) | 2 | 2 | 0,02 | 2 |
| Young (0.5 months to 1 year) | 10 | 12 | 0,1 | 10 |
| Adult (1-6.5 years) and mature adult (6.5-9.75 years) | 41 | 53 | 0,42 | 42 |
| Older (9.75-13 years) | 35 | 88 | 0,36 | 36 |
| Geriatric (over 13 years) | 10 | 98 | 0,1 | 10 |
| **Total** | 98 | | 1 | 100 |

Source: Own elaboration.

Figure 11. Pie chart of age distribution of female Dachshund dogs diagnosed with spinal column alterations in a veterinary clinic between 2019-2023 in the city of Puerto Montt.



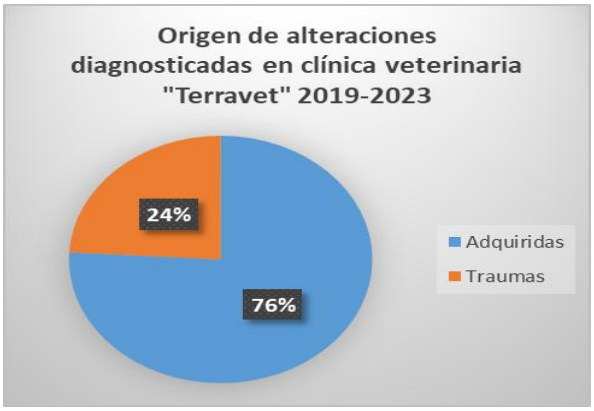

Traumatic affections were defined as those resulting from events with a certain degree of violence, causing a conformational disturbance, in this case, of the spinal column, such as fractures and musculoskeletal injuries. In the Dachshund breed, due to its genotypic characteristics, specifically at the level of the FGF4L1 and FGF4L2 retrotransposons, it is possible to diagnose alterations at early stages that do not frequently manifest in non-chondrodystrophic or non-chondrodysplastic breeds. In the present study, the latter were classified as acquired and were detected in 76% of the patients, Table 5 and Figure 12.

Table 5. Frequency of origins of spinal column alterations diagnosed in Dachshund canines in a veterinary clinic between 2019-2023 in the city of Puerto Montt.

| Origin | Patients | Fi | hi | %hi |
|---|---|---|---|---|
| Acquired | 186 | 186 | 0.76 | 76 |
| Traumatic | 59 | 245 | 0.24 | 24 |
| **Total** | **245** | | **1** | **100** |

Source: Own elaboration.

Figure 12. Pie chart of origins of spinal column alterations diagnosed in Dachshund canines in a veterinary clinic between 2019-2023 in the city of Puerto Montt.




Source: Own elaboration.

## Discussions

Regarding the affected vertebral segment, in the present study, 49% of cases were linked to the thoraco-lumbar segment. These results are similar to studies such as that carried out by (5), where 48.7% of the studied population presented affections at the lumbar region level and 33.9% of the studied population presented affections at the thoracic region level, where T10 and L3 were identified as the intervertebral spaces with the highest number of lesions. The thoraco-lumbar zone is the most unstable region of the spinal column due to a decrease in the thickness of the intercapital ligament and the high mobility demonstrated in this anatomical region.

Among the various anatomical structures that participate in the conformation of the spinal column, the highest presentation was observed at the level of the intervertebral discs, occurring in adult patients in 55% of males and 40% of females. Studies conducted by (6), (7), (8), confirm that the chondrodystrophic genotypic characteristic predisposes to the presentation of affections related to cartilaginous structures such as intervertebral discs.

Studies such as that by (9) state that in canines, the worldwide presentation rate of disc herniation is 2% with a prevalence of 25% in specific breeds such as the Dachshund, which has been recognized since times like those of (10) for its high incidence of disc herniation, where it represented from 45% to 70% of all cases. For (11), the sex of the animal is not a determining factor in the presentation of osteoarticular diseases; however, between 2019 and 2023 at the Terravet clinic, 62% of the Dachshund patients attended were males, Figure 9.

(12) states that overweight increases the likelihood of developing osteoarticular problems, to which (13) and (14) affirm that under these characteristics, females are more prone to obesity, which would suggest a greater likelihood of developing spinal column problems; however, in this case, it is suspected that males are more vulnerable to the presentation of alterations of this nature due to their tendency to be more active according to studies such as (15) and a lower production of estradiol, a hormone that according to various studies such as (5) has protective effects in cases of intervertebral disc degeneration.

Regarding age, the results coincide with (16) where 80.4% of their studied population under the criterion of disc herniation presentation was found in the adult age range (1 to 7 years), and although the present study does not focus only on intervertebral disc diseases, it is the main pathology affecting the breed in terms of spinal column.

(17) indicates that from one year of age, the prevalence of spinal column problems increases by 20%, which suggests that aging is one of the main risk factors. Furthermore, we must remember that overweight is one of the main contributors to the expression of various alterations in the musculoskeletal system, especially at the axial skeleton level, to which (18) confirms that in most canines, an increase in body condition is evidenced between one and six years of age, age ranges that coincide with the ages of highest presentation of problems of this nature.

## Conclusions

Of a total of 245 Dachshund canine cases evaluated for suspected spinal column alterations, 49% revealed thoraco-lumbar segment involvement, supporting the idea that this particular area is highly vulnerable due to its high mobility. Correct anamnesis, general physical examination, and neurological examination were key to identifying these problems, evidencing the importance of a comprehensive evaluation.

Depending on the symptomatology a patient manifest, one can obtain a long list of pre-diagnoses, which, thanks to imaging, can be ruled out to reach a definitive diagnosis. In the present study, it was possible to diagnose intervertebral disc disease in 61% of the patients, highlighting the importance of understanding the specific genetic predispositions of Dachshunds, which could guide future preventive strategies and more effective treatment in this canine population.

In the present study, 62% of the patients were males, presenting differences with some studies where they indicate that sex is not a predisposing factor to the manifestation of spinal column alterations. Thanks to this finding, a greater complexity in the relationship between sex, physical activity, hormonal factors, and of course, the predisposition to spinal diseases in this breed is suggested.

The results showed that, in both males and females, spinal column alterations tend to occur more frequently in the adult-mature age range, highlighting aging and overweight as the main causes. This study revealed that 76% of the patients presented alterations classified as acquired, highlighting the relevance of the distinctive genotypic characteristics of the studied breed in particular.

It is important to continue with this type of study with the idea of early identification of a greater number of clinical presentations and to have adequate treatment according to the diagnosed alteration in order to improve the patient's quality of life.

## Conflict of interest

Author declares no conflict of interest for the study.

## Acknowledgments

This study has not received any financial support. There was no contribution from other colleagues. All research work was carried out through the cooperation of the Terravet veterinary clinic.

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# 2. High-Resolution Infrared Imaging for Leg Wound Monitoring in a North Carolina Stable. Clinical case

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**Summary:**

**Introduction:** Equine limb wounds are common injuries that often require prolonged healing periods. Thermography, a non-invasive, non-contact, non-ionizing radiation imaging technique, is a valuable resource for clinical imaging. **Objective:** To describe the clinical, photographic, and thermal behavior of a wound in a horse at stable foot over a three-week period, and its quantitative thermal description linked to the predefined wound bed and surrounding areas.

**Case:** Around June 21, 2025, an 8-year-old Quarter Horse mare used for pleasure riding sustained a deep laceration wound in the area of the left hind cannon bone. The wound was assessed and cleaned by a veterinarian approximately 24 hours later of the injury, it was determined that it was too swollen for sutures and prescribed a course of oral antibiotics for 10 days.

**Conclusion:** Thermal imaging revealed patterns in the thermal profile, similar to those reported by Higashima et al. (2014) and Machado et al. (2024), which correlated with clinical improvement and helped observe changes in inflammation and tissue regeneration.

**Keywords**: Equines, laser, thermography, healing, thermal profile

**Aim:**
The objective of this work is to describe the clinical, photographic and thermographic behavior of a wound in a horse at stable foot, during three weeks, and its quantitative thermal description linked to the bed and areas surrounding the predefined wound.

**Case description**
Around June 21, 2025, an 8-year-old Quarter Horse mare used for pleasure riding sustained a deep laceration to the left hind cannon bone. The owner reports finding the mare in the morning and is unaware of what occurred overnight in the field. The wound was located medial and cranial to the midcannon bone, distal to the hock joint. A veterinarian evaluated and cleaned the wound approximately 24 hours after the injury. It was determined to be too swollen for sutures and was prescribed a course of oral antibiotics (SMZ) once daily for 10 days. Dressing and cleaning/debridement of the wound was prescribed with dressing changes every other day for the first 3 weeks. The owner was required to provide photos of the wound at each dressing change to the veterinarian for evaluation of its appearance. After completing the antibiotic course, the owner had concerns about the

Possibility of local infection. It was decided to seek veterinary approval for laser therapy, which was received on July 3, 2025. A follow-up veterinary appointment was scheduled for wound observation on July 14, 2025. The horse was examined and found the wound appeared clean and showed signs of healing, with no signs of infection. At that time, the owner allowed the horse to return to grazing and walking in hand. The wound continued to be monitored with a poultice, reapplied every two days to keep it clean of dirt and flies.


*Figure 1. Image of the traumatic wound, photograph of the image and definition of the regions of interest studied in this wound, A, B, C representative circles of the analyzed profiles*

## Materials and methods

### Thermography protocol:

After removing the bandage, thermographic images of the wound were taken before each laser session.

A high-resolution infrared sensor, FLIR e8XT (FLIR Systems AB, Sweden), was used for bedside recording. This infrared system has a resolution of 320 × 240 (76,800 pixels), thermal sensitivity/NETD < 0.05°C / < 50 mK, with a spectral range of 7.5–13 µm. Field of view (FOV) of 45 × 34° (6.7 mm lens), spatial resolution (IFOV) of 2.6 mrad/pixel, F-number of 1.5, frame rate of 9 Hz, with Focus Free (Teledyne FLIR LLC, OR, USA).

A certified veterinary thermographer obtained all images and applied LLLT on the same date as the session. All thermal images were processed remotely in real time by a certified thermologist at the point of care.

To acquire thermal images of this horse, the veterinary wound thermography protocol (AUTERM Vet protocol) was used. This protocol consists of taking thermal images 30 cm from the ROI, with frontal positioning, good lighting, and a neutral background. The wound is left uncovered for at least 10 minutes before thermal imaging. The analysis focuses on the thermal profile of three areas of the wound.

A high-resolution fixed-focus sensor, as described above, is used, with an emissivity of 0.98, a humidity of 60% ± 10%, an ambient temperature of 25% ± 1°C, and MSX at 30 cm. These images require a minimum resolution of 76,800 pixels and a thermal sensitivity already mentioned in the data sheet for the sensor used. Three imaging sessions were conducted during this period: July 9, 17, and 26, 2025.

The environmental conditions were virtually the same, ensuring the same time of day and stable conditions were maintained during each session. The horse was placed in the same stable, against the same wall, to maintain consistency throughout each session. Periodic images of the affected limb (both medially and laterally) were taken to compare temperature along the wound thermal profile. Three regions within the wound were studied: A: External wound, B: Periwound, and C: Wound bed. These regions were studied along the thermal profile line, with their behavior graphically represented by pixel scaling as a function of temperature. Thermograms were analyzed using FLIR IR Research using thermal profiles in the three wound areas over the course of several weeks.

A hygrometer was used to record the temperature and humidity of the environmental area in each session.

The ambient heat and humidity indices were measured:

| | |
|---|---|
| 7/9 | 32°C/64% humidity |
| 7/17 | 29°C/85% humidity |
| 7/21 | 34°C/56% humidity |

**Laser therapy protocol:**

Laser sessions recommended and approved by veterinarians:

History: Wound of 12 days' duration (as of July 3, 2025), in the subacute phase, deep (approximately 10 cm long by 3 cm wide), vertical laceration on the medial and cranial aspect of the left hind leg, just distal to the hock. Unknown etiology (suspected trauma due to entrapment of the horse's leg in a fence). Under veterinary supervision 24 hours after wound onset. 10 days of oral antibiotic treatment, without sutures due to excessive inflammation.

Objective: The owner desires veterinary approval for laser treatment to attenuate scarring, granulation, and epithelialization of the tissue. Distal extremities (such as this one in the cannon bone area) exhibit slow epithelialization and often a tendency toward excessive granulation ("prominent flesh"). (4) LLLT has been clinically shown to help prevent excessive granulation. Suggested laser protocol provided to the owner, approved by the veterinarian on July 3, 2025.

Method: As the owner changes the dressing, the laser is scanned in pulsed mode approximately 1 cm from the wound (or, if tolerated, directly over the wound), covering an area of approximately 25 cm.

Dose: 10-12 J/cm² pulsed scanning over the area for 5 minutes every other day (<300 J delivered per session). Reduced to 6 J/cm² per session twice weekly (beginning week 2, July 17) to reduce overstimulation. Beginning July 26, 2025, laser application continues twice weekly until complete tissue granulation is achieved (as directed by the veterinarian). Equipment in use: Multi Radiance TQ Solo (Class 3b/1000 W)

**4. Results**

| **date** | **image** | Notes on observations/conditions |
|---|---|---|
| July 9 | 1 | The poultice had been washed off before imaging. |
| July 17 | 2 | The poultice had been washed before imaging with some moisture. |
| July 26 | 3 | The poultice had been washed before imaging and was dry. |

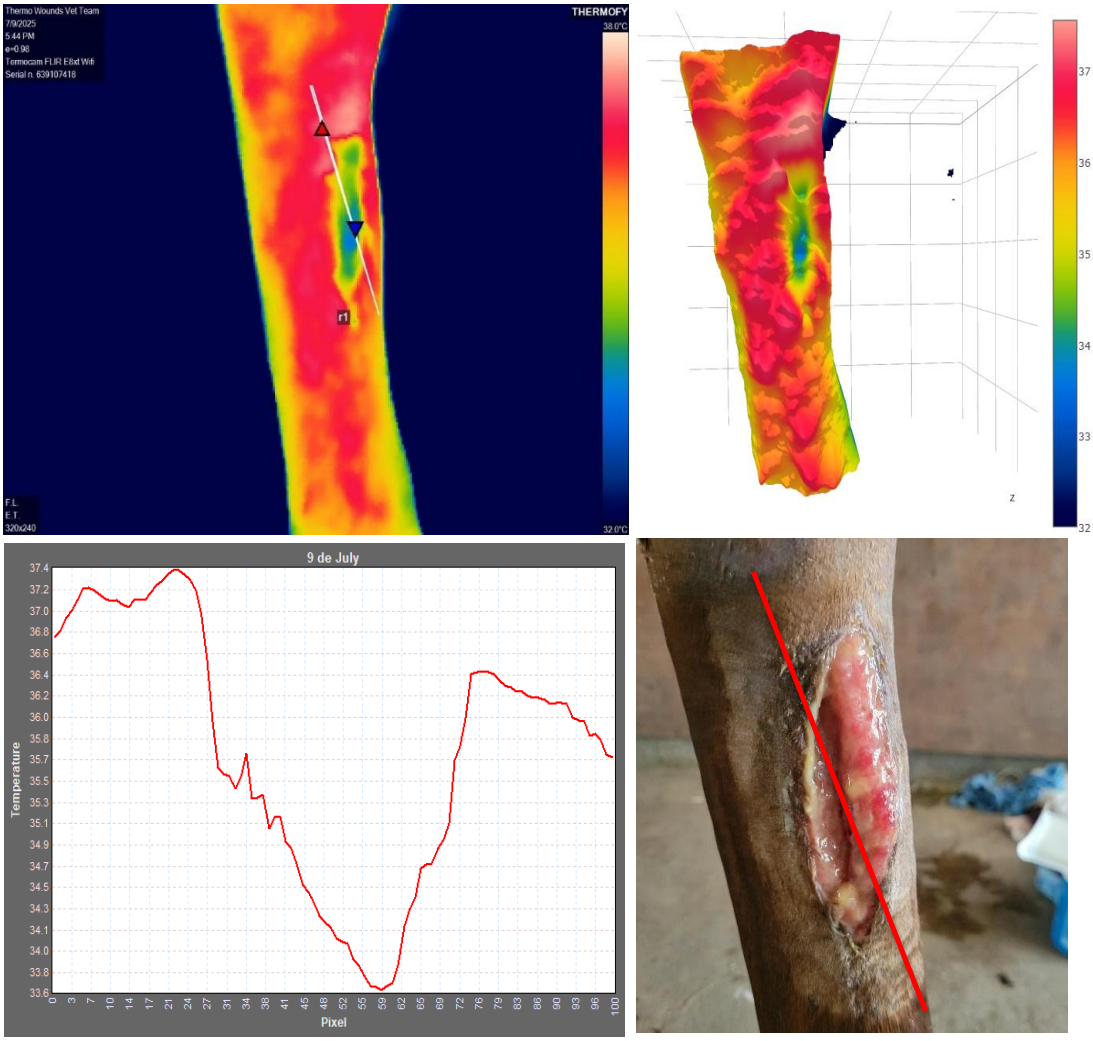


*Figure 2: Thermal image 1 from day 9, showing areas of hyperemia over the areas of interest: Outside wound, Periwound, and Bedwound. Reference profiles from day 9 show the wound presenting a cold bed pattern and elevated occult thermal hyperemia, expected for the wound type. Representative image from wound analysis.*

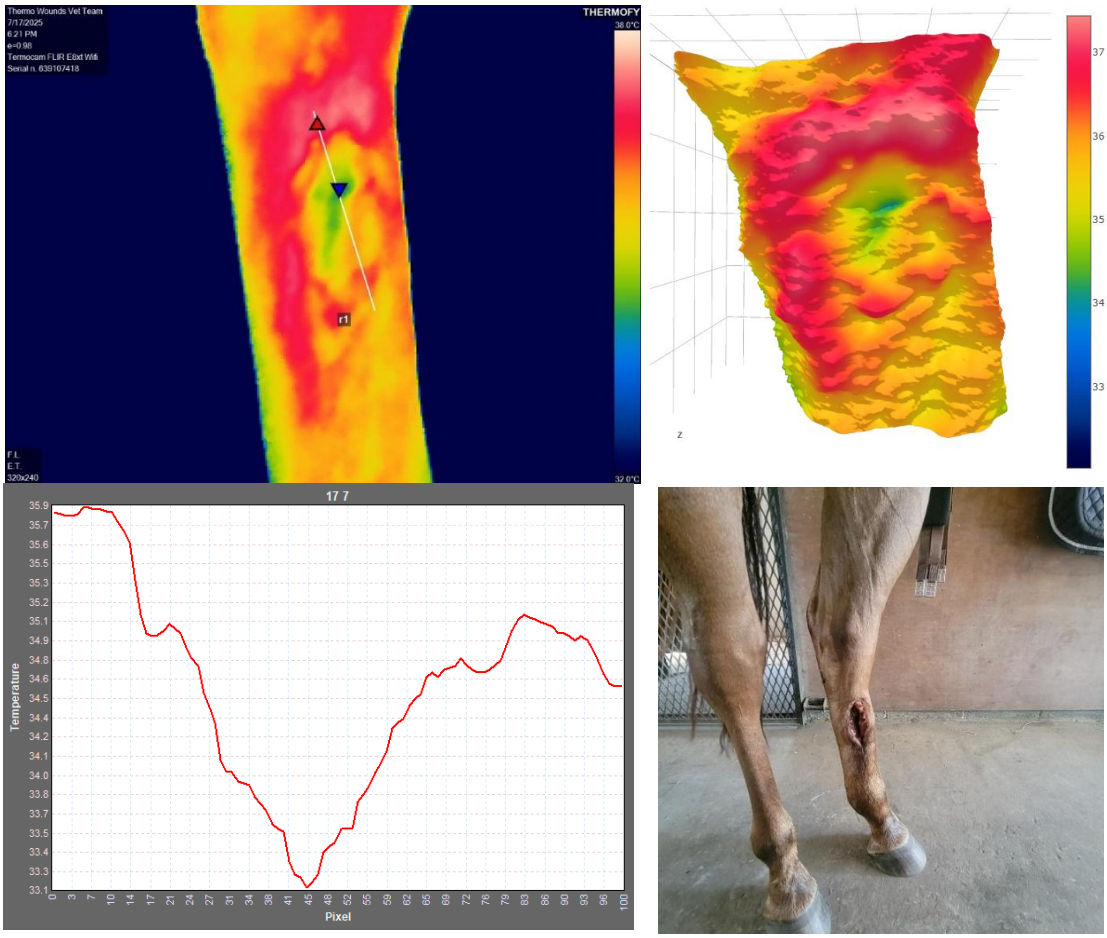


*Figure 3: Thermal image 2 from day 17, areas of hyperemia are observed over the areas of interest Outside wound, Periwound, bed Wound. Reference profiles from day 9 July, we see how the wound presents a cold bed pattern and elevated hidden thermal hyperemia, expected for the type of wound. Representative image of wound analysis*

.

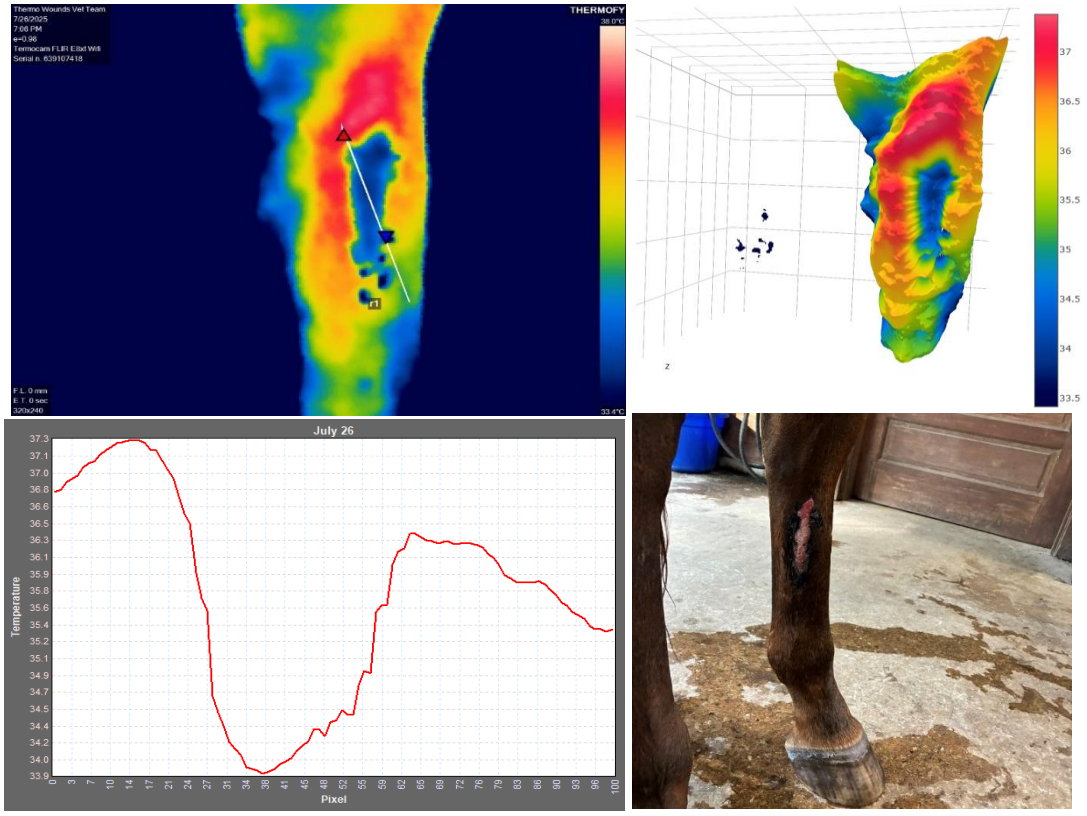


*Figure 4: Thermal image 3 from day 26. Areas of hyperemia with a slight decrease in temperature are observed over the areas of interest: external wound, periwound and wound bed. Reference profiles from July 26. It can be seen how The wound has a cold bed pattern and elevated occult thermal hyperemia, as expected for this type of wound. Photograph of the wound*

## Discussion

Thermal images show a clear profile pattern. Occult thermal hyperemia was observed in all three regions studied for the three weeks. Temperatures remained between 36.8 and 34.6°C between the first and last week of follow-up in areas A and B. The wound bed reached homogeneity at pixels 31 and 56 in the last week, with a minimum temperature of 33.9°C, with the largest distribution in the last week. This possibly indicates the expected cellular turnover as healing progresses.6,8,10 These events were reported by Machado et al. in 2024. Studies from 2024 reported the importance of the environment as a confounding factor during thermography.7,10,13

Higashimo et al. reported in 2014 on the importance of differentiating between warm wound beds and cold wound beds, according to the stage of the wound's development, as in this reported case. Furthermore, the importance of the presence of HTO around the wound, whether complete or partially complete, is the expected pattern.

Machado et al. (2025) report specific wound patterns according to the evolutionary stage, with the wound bed expected to be warm during the first two weeks, and its temperature changing from week 3.10,12,13

Getting accurate and stable images at close range (30 cm) can be difficult (and dangerous), but with patience, we can do it.14

The horse's owner had washed the area several times just before thermography. Some days, a dry medicated topical poultice was left on, while other days the wound was left uncovered and sometimes moist. As the wound healed, the owner received veterinary advice to remove the dressing and allow the wound to ventilate. This posed a problem from a thermographic perspective, as the environmental conditions of the wound could not be consistently obtained. The poultice was placed to keep flies away during the day while the horse grazed.

The conditions were typical of any stable imaging session: people coming and going to care for their horses, fans on due to the intense heat, and wind blowing through the stable doors or windows. We were able to turn the fans off for a few minutes while taking thermal images inside the stable (this didn't make us popular with visitors, as it was very hot and humid). Humidity was a highly variable factor and could have influenced the images.

Thermal imaging. This must be taken into account when performing point-of-care imaging. Environmental conditions will always be difficult, but it is a responsibility

The thermologist must keep a record of the variables for the interpretation of thermograms.

Clinical value: While no clinical decisions were made based on the thermographic information in this case (as the wound appeared to be healing well and steadily), if the thermographic images had yielded any alarming information, coupled with an obvious clinical observation, there may have been an opportunity to intervene quickly. The horse's owner felt reassured knowing that the measurement was performed every other day, as the veterinarian could only view the images remotely and not be present for in-person observation every other day. From a financial perspective, it was more cost-effective for the ESMT/thermographer to perform the laser and thermography in the same sessions than to pay the fee for the veterinary visit. The veterinarian was able to remotely monitor and visually verify the progress of the wound healing without having to make a field visit. Field visits, visual observations, and wound inspection proceeded as normal, based on the receipt of images and reports.

Impact of Laser Therapy: Laser therapy appeared to be effective in preventing excessive granulation (prominent flesh) formation. According to a subjective report from the horse's owner, she noticed the wound area and the upper region of interest swell slightly one day after the laser session and then decreased immediately afterward. She felt the laser was helping to reduce the swelling. Initially, the horse was uncomfortable remaining still during the imaging and laser sessions. While not limping, it was tender and protective of the area.

Conclusion: Thermography provided a consistent, noninvasive method for monitoring wound healing in the leg of an equine patient. 3,5,8

Thermal images revealed patterns in the thermal profile, similar to those reported by Higashima et al. (2014) and Machado et al. (2024), which correlated with clinical improvement and helped observe changes in inflammation and tissue regeneration. 5,7,10 There is a possible clinical, semiological, photographic, and thermological correlation of the wound in this case. 2,4,912

This case demonstrates the value of thermography as a complementary diagnostic tool in the management of equine wounds, especially when combined with complementary therapies such as laser treatment. Studies with a sufficient number of cases are needed to verify statistical significance.

**Copyright Statement**



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# 3. Platelet-Rich Plasma as a potential Regenerative Therapy in Canine Degenerative Myelopathy: A Review of causes, conventional treatments, and Scientific Evidence for Intramedullary Infusion

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**Abstract:** Canine degenerative myelopathy (DM) is a progressive and incurable neurodegenerative disease that affects the spinal cord, leading to a gradual loss of motor and proprioceptive function. Conventional treatments offer limited symptomatic relief, underscoring the need for innovative therapies. Platelet-rich plasma (PRP), a concentrated autologous source of growth factors, has demonstrated regenerative potential in various tissues. This article reviews the etiology, pathogenesis, and conventional treatments of canine DM, and explores the potential of hyperconcentrated PRP as a regenerative therapy, specifically through intramedullary infusion for axonal regeneration. The mechanisms of action of PRP and the scientific evidence available in human and veterinary medicine supporting its use in nervous system injuries are discussed. While specific research on canine DM with intramedullary PRP infusion is limited, preclinical evidence suggests neuroprotective and regenerative effects. Technical and biosafety considerations for the development and application of PRP are addressed. Finally, the urgency of future rigorous research to evaluate the safety and efficacy of this promising therapy in canines with DM is highlighted, offering a potential new way for addressing this devastating disease.

**Keywords:** "Canine Degenerative Myelopathy ", "SOD1 mutation dog ", " canine spinal cord disease ", " platelet-rich plasma PRP veterinary ", "PRP spinal cord injury " , " intramedullary PRP infusion

For the development of this review, a systematic search of scientific literature was conducted in recognized electronic databases, including PubMed, ScienceDirect, Scopus, Google Scholar, and SciELO, covering the period from January 2018 to April 2025. The search strategy combined descriptors in both English and Spanish using Boolean operators, with terms such as: “canine degenerative myelopathy,” “platelet-rich plasma,” “intramedullary infusion,” “spinal cord regeneration in dogs,” “regenerative therapies in veterinary neurology,” “mielopatía degenerativa canina,” “plasma rico en plaquetas,” and “terapia regenerativa intramedular.”

The inclusion criteria encompassed original studies (clinical trials, case studies, and experimental studies in animal models), systematic reviews, meta-analyses, and narrative review articles addressing at least one of the following aspects:

(a) the pathophysiology of canine degenerative myelopathy,
(b) currently available conventional treatments,
(c) application of PRP in regenerative therapies targeting the nervous system,
(d) evidence of intramedullary use of PRP in canine models or other animal species.

Inclusion criteria were:

Publications in English, Spanish, or Portuguese;
Studies published in peer-reviewed scientific journals;
Articles with full-text access.

Exclusion criteria included:

Duplicate studies,
Conference abstracts lacking complete data,
Publications exclusively focused on human medicine without clear veterinary comparative relevance or translational applicability.

The selected information was organized and qualitatively analyzed, with a focus on methodological rigor, clinical relevance, and thematic pertinence in relation to the objectives of the review.

**INTRODUCTION:**

Myelopathy **(DM)** is a progressive and incurable neurological disease in dogs, primarily caused by a genetic mutation in the SOD1 gene (1) (2). It is characterized by gradual degeneration of the spinal cord, leading to progressive loss of motor function and proprioception, typically beginning in the hindlimbs with weakness and incoordination (ataxia) (3). As it progresses, it may affect the forelimbs and cause incontinence, eventually culminating in paralysis. It is not a painful disease. *Diagnosis is based on clinical history, neurological examination, exclusion of other diseases, and genetic confirmation* (4). There is currently no cure, and treatment focuses on symptom management and physiotherapy to maintain quality of life for as long as possible (5).

**Study Relevance:** Degenerative myelopathy (DM) represents a significant challenge in veterinary medicine due to its progressive, irreversible, and ultimately fatal nature. Currently, there is no cure for this neurological disease that affects the quality of life and well-being of numerous canines. Conventional treatments are limited to symptomatic management and attempts to slow disease progression, but fail to halt or reverse it (6).

**Limitations of Current Treatments:**

**Symptomatic management:** Current therapies, such as physical therapy and exercise, although beneficial in maintaining mobility and muscle strength for a time, do not address the underlying cause of spinal cord degeneration and their effectiveness decreases as the disease progresses (7).

**Controversial drug efficacy:** The use of corticosteroids to reduce inflammation is debated due to their long-term side effects and a lack of solid evidence of their ability to significantly alter the course of the disease. Supplements and antioxidants have also not been consistently shown to halt or reverse the progression of DM (6).

**Impact on quality of life:** As DM progresses, affected dogs experience a gradual loss of motor function, hampering their ability to move, exercise, and even perform basic activities such as getting up and doing their business. This leads to a significant decline in their quality of life and an increasing dependence on their owners (1).

**Euthanasia Dilemma:** Given the incurable and progressive nature of DM, euthanasia becomes an unavoidable consideration to alleviate the animal's suffering in the advanced stages of the disease. The lack of effective therapies prolongs this process and creates distress for both the dog and its owners (5).

**Importance of Research into New Therapies:**
Given this situation, research into new therapies for canine DM becomes crucial and of utmost importance for the following reasons:

**Unmet need:** There is a clear unmet need for treatments that go beyond symptomatic management and can halt, significantly slow, or even reverse the degenerative process in the spinal cord.

**Potential to improve quality of life:** The development of effective therapies could prolong the lives of affected dogs, but more importantly, could significantly improve their quality of life by preserving their mobility and independence for a longer period (3) (5).

**Benefits to owners: Effective** treatment would alleviate the emotional and physical burden owners face when caring for a dog with progressive DM and postpone the difficult decision of euthanasia (7).

**Advancing scientific knowledge:** Research into canine DM not only benefits dogs, but may also contribute to advancing knowledge about similar neurodegenerative diseases in other species, including humans (given the similarity with Amyotrophic Lateral Sclerosis - ALS) (1).

**Exploring innovative approaches:** The incurable nature of DM calls for the exploration of innovative therapeutic approaches, such as gene therapy, stem cells, neuroprotective agents, and regenerative therapies such as platelet-rich plasma (PRP). Investigating the potential of intramedullary PRP infusion for axonal regeneration represents a promising way that merits rigorous scientific exploration (8) (9).

**Objective of the Article:** The purpose of this article is to delve into the study of canine degenerative myelopathy (DM). First, we comprehensively review the underlying causes and pathophysiological mechanisms involved in the development of the disease. Second, we critically analyze the conventional treatments used to date, assessing their efficacy and limitations based on the available scientific evidence. Finally, we explore the therapeutic potential of platelet-rich plasma (PRP) as an innovative regenerative strategy, with emphasis on the intramedullary infusion technique. We discuss the biological mechanisms involved, and examine the existing evidence on its application in axonal regeneration and the improvement of clinical signs in affected canines.

**Canine Degenerative Myelopathy:**

Degenerative myelopathy (DM), also known as chronic progressive myelopathy or degenerative spinal cord disease, is a progressive and incurable neurological disease that affects the spinal cord of dogs (3). It is characterized by a gradual degeneration of the white matter of the spinal cord, specifically of the tracts that transmit information about limb position and movement (proprioceptive tracts) and the tracts that control voluntary movement (corticospinal and rubrospinal tracts) (3) (1) (10). This degeneration leads to a progressive loss of motor and proprioceptive function, typically beginning in the hind limbs and ascending over time.

**Etiology and Genetics:**

One of the most important causes of DM is a genetic mutation in the gene that encodes superoxide dismutase 1 (SOD1) (1). This enzyme is responsible for neutralizing free radicals within cells. The specific mutation implicated in canine DM is an adenine to guanine substitution in exon 2 [1] of the SOD1 gene, resulting in an amino acid change (glutamic acid to lysine at position 40, often abbreviated as SOD1:c.118G>A (1)).

DM is inherited in an autosomal recessive manner. This means that a dog must inherit two copies of the mutated gene (one from each parent) to develop the disease. Dogs with only one copy of the mutated gene are considered carriers and will not show clinical signs of the disease, but they can pass the mutated gene on to their offspring (11).

While the mutation in the SOD1 gene is perhaps the most relevant identified cause, other possible genetic or environmental factors that could influence the age of onset and progression of the disease are being investigated. Not all dogs homozygous for the SOD1 mutation develop DM, suggesting the possible existence of modifier genes or environmental factors that are not yet fully understood (1) (11).

**Pathogeny:**

At the pathological level, DM is characterized by:

**White matter degeneration:** The main feature is the degeneration and loss of myelin (demyelination) and axons in the spinal cord tracts. This degeneration is most pronounced in the thoracic and lumbar regions of the spinal cord (6).

[1]region of DNA within a gene that is found in mature messenger RNA (mRNA) and contains the information to make a protein

**Gliosis:** In response to degeneration, glial cells (astrocytes and microglia) proliferate in the affected areas. This gliosis is a chronic inflammatory response that attempts to repair damage, but it can also contribute to disease progression (6).

**Accumulation of abnormal proteins:** Aggregates of mutated SOD1 proteins have been found in the spinal cord cells of affected dogs, suggesting a role for the misfolded protein in the degenerative process (12).

**Chronic inflammation:** Inflammation plays an important role in the pathogenesis of DM, contributing to neuronal damage and disease progression (12).

**Clinical Signs:**
DM typically presents in adult dogs, usually between 5 and 14 years of age, although it can occur in a wider range. The progression of clinical signs is gradual and may vary among individuals (6). The most common clinical signs include:

**Hind limb weakness and incoordination (ataxia):** This is the most common initial sign. Dogs may drag their hind limbs, have difficulty rising, stagger, or have an unsteady gait (6).

**Loss of proprioception:** Proprioception is the ability to sense the position of the limbs in space (7). Dogs with DM often show decreased or absent proprioceptive feedback in the hind limbs (e.g., they are slow to correct the position of the paw when it is turned) (7).

**Progression to the forelimbs:** As the disease progresses, weakness and incoordination spread to the forelimbs. Initially, this may manifest as difficulty maintaining balance or an awkward gait (7).

**Urinary and fecal incontinence:** In advanced stages of the disease, degeneration of the spinal cord can affect the nerves that control the bladder and bowel, leading to incontinence (5).

**Paralysis:** Eventually, the progression of degeneration leads to complete paralysis of the hind limbs and, in some cases, all four limbs (5).

**Spinal reflexes:** Spinal reflexes in affected limbs may be normal or even hyperactive in the early stages, but may be diminished or abolished in the later stages due to significant axonal loss (7) (13).

**Absence of pain:** It's important to emphasize that MD is not a painful disease in itself. The absence of pain is a distinctive feature that helps differentiate it from other spinal cord diseases that can cause pain (13).

**Diagnosis:**
The diagnosis of DM is based on a combination of:

**Clinical history and neurological examination:** The progressive presentation of clinical signs, absence of pain, and neurological examination findings (progressive ataxia, loss of proprioception) are highly suggestive of DM (6).

**Laboratory tests:** Blood and urine tests are performed to rule out other metabolic or infectious diseases that may cause similar neurological signs (6).

**Imaging (Magnetic Resonance Imaging - MRI):** Spinal cord MRI is primarily used to rule out other compressive or inflammatory lesions of the spinal cord (such as herniated disks, tumors, or myelitis), since MD itself typically does not show significant structural changes on MRI in the early stages. In advanced stages, there may be subtle signs of spinal cord atrophy (6).

**Genetic testing for the SOD1 mutation:** This is the definitive test to confirm a genetic predisposition to DM. A positive homozygous result (the presence of two copies of the mutated gene) in a dog with compatible clinical signs confirms the diagnosis. However, it is important to remember that not all homozygous dogs develop the disease (1) (4).

**Diagnosis by exclusion:** DM is often diagnosed by exclusion of other spinal cord diseases that can cause similar signs (4) (6).

**Predisposed Breeds:**
While DM can affect any breed, a higher prevalence has been observed in certain breeds, including: Boxer;German Shepherd;Rhodesian Ridgeback;Pembroke Welsh Corgi;Cardigan Welsh Corgi;Chesapeake Bay Retriever;Bernese Mountain Dog;Old English Sheepdog

**Prognosis and Treatment:**
The prognosis for dogs with DM is guarded to poor. The disease is progressive and incurable, and most affected dogs eventually lose the ability to walk and require euthanasia due to a loss of quality of life (13) (3) (5).

Conventional treatments focus on symptom management and slowing disease progression, although their effectiveness is limited (5). These include:

**Physical therapy and rehabilitation:** Low-impact exercises, aquatic therapy, and other rehabilitation modalities can help maintain muscle strength, mobility, and coordination for as long as possible.

**Medical management:** Corticosteroids can be used to reduce inflammation, although their long-term benefits are controversial. Antioxidant supplements such as vitamin E and B complex may also be considered, although evidence of their effectiveness is limited.

**Supportive care:** Providing a safe environment, avoiding slippery surfaces, assisting with mobility (harnesses, supports), managing incontinence, and preventing pressure ulcers are important aspects of management.

**Current Research:**
Various therapies for DM are currently being investigated, including genetic approaches, stem cell therapies, and neuroprotective agents. Platelet-rich plasma (PRP) therapy as a potential regenerative strategy is also an area of interest (14).

**Conventional Treatments for Degenerative Myelopathy:**

Pharmacological management of degenerative myelopathy (DM) in canines has historically focused on mitigating inflammation, offering neuroprotective support, and improving neurological function through various agents. However, it is crucial to note that, given the progressive and degenerative nature of the disease, no drug has been consistently shown to halt or reverse its course (11). Evidence supporting the long-term efficacy of many of these treatments is limited and, in some cases, controversial.

**Corticosteroids:**
Corticosteroids, such as prednisolone, have been used in canine DM primarily for their anti-inflammatory and immunomodulatory properties. The theory behind their use lies in the possibility that inflammation contributes to the degenerative process in the spinal cord (11). While corticosteroids may provide short-term symptomatic improvement by reducing inflammation and edema, their long-term efficacy is questionable.

**Potential Short-Term Benefits:** Some clinicians have observed a transient improvement in motor function and a reduction in the progression of clinical signs in some patients treated with corticosteroids in the early stages of DM. This may be due to a decrease in inflammation around the affected neurons (5) (13).

**Limitations and Controversies:**
**Significant side effects:** Prolonged use of corticosteroids is associated with a wide range of adverse side effects, including polydipsia, polyuria, polyphagia, weight gain, immunosuppression, predisposition to infections, gastrointestinal ulcers, and steroid myopathy, which could further impair the animal's quality of life (3) (6).

**Masking of progression:** Initial symptomatic improvement may mask the underlying progression of degeneration, making it difficult to truly assess treatment efficacy (6).

**Limited action:** Corticosteroids do not address the root cause of DM (the SOD1 mutation and its pathological consequences at the cellular and molecular level) (1).

**Vitamins (B Complex and Vitamin E):**
The use of vitamins, particularly the B complex and vitamin E, is based on their potential as neuroprotectors and antioxidants.

**B-complex:** B vitamins play a crucial role in nerve function. It has been theorized that supplementation could support neuronal health and nerve transmission. However, evidence shows that their effectiveness in canine DM is limited (7) (5) (13). While they are generally safe, they have not been shown to halt spinal cord degeneration.

**Vitamin E:** Vitamin E is a potent antioxidant that may help protect cells from free radical damage. Since oxidative stress may be involved in the pathogenesis of DM, vitamin E supplementation has been suggested. However, as with B complex, robust clinical evidence supporting its efficacy in slowing the progression of DM is limited (13). Some in vitro studies and studies in animal models of other neurological diseases suggest antioxidant benefits, but these results do not always translate to clinical practice in canine DM (3) (13).

**Other Supplements:**
A variety of other supplements, such as omega-3 fatty acids, coenzyme Q10, acetyl-L-carnitine, and various nutraceuticals, are often used in the management of DM in the hope of providing neuroprotective or anti-inflammatory support (7) (6).

**Limited evidence:** Overall, the scientific evidence supporting the effectiveness of these supplements in canine DM is limited and is often based on anecdotal reports or studies with small sample sizes and without adequate control groups (7) (3).

While some of these supplements have theoretical mechanisms of action that could be beneficial in neurodegenerative diseases (e.g., anti-inflammatory or antioxidant properties), their ability to penetrate the blood-spinal barrier at therapeutic concentrations and exert a significant effect on the course of DM in dogs has not been conclusively demonstrated (6) (7).

**Conclusion on Conventional Medicines:**
An evaluation of the available scientific evidence indicates that *conventional pharmacological treatments, including corticosteroids and vitamin supplements, have not been shown to be effective in halting or significantly slowing the progression of degenerative*

*myelopathy in canines***.** While some may offer temporary symptomatic relief, they do not address the underlying cause of the disease, and their long-term benefits are minimal or nonexistent.

This *lack of effective medical therapies* underscores the *urgent need to investigate novel therapeutic strategies***,** such as platelet-rich plasma therapy, that may offer a more direct approach to regenerating nerve tissue and modifying the course of this devastating disease. Current evidence primarily supports *intensive physical therapy and rehabilitation as the best strategy for maintaining mobility and quality of life* in dogs with DM for as long as possible, although even these do not halt disease progression.

**Physiotherapy and Rehabilitation:**

Since there is no cure for Degenerative Myelopathy (DM) and conventional pharmacological treatments have limited effectiveness in modifying the disease in the long term, physical therapy and rehabilitation remain a crucial and fundamental component in the management of canine DM (7). Although they do not halt the progression of spinal cord degeneration, a well-designed and consistently implemented rehabilitation program can offer significant benefits in maintaining mobility, muscle strength, coordination, quality of life and potentially slowing the onset of secondary complications.

A comprehensive physical therapy and rehabilitation program for canines with DM typically includes a combination of various modalities, tailored to the stage of the disease and the individual needs of the patient (7).

**1. Muscle Strengthening Exercises:**

The main objective of muscle strengthening exercises is to maintain and, as far as possible, increase muscle mass and strength, especially in the hind limbs, which are the first to be affected (7) (12).

Gentle slopes and ramps
Weight-bearing exercises
Weight transfers: Resistance band exercises
Low-impact exercises

**2. Aquatic Therapy (Hydrotherapy):**

Aquatic therapy, which includes the use of underwater treadmills
Support and impact reduction:
Endurance:
Cardiovascular improvement:
Increased range of motion:

Proprioceptive stimulation

**3. Therapeutic Massages:**

Therapeutic massage provides:
Muscle relaxation
Improved circulation
Pain reduction
Proprioceptive stimulation
General well-being

**4. Electrostimulation:**

Neuromuscular electrical stimulation (NMSS) and functional electrical stimulation (FES) can be used to:

Muscle strengthening
Improved function:
Pain control (in cases of secondary discomfort) TENS

**5. Metabolic Stimulation (Low Impact Aerobic Exercise):**

Although aerobic exercise capacity may be compromised by weakness, keeping low-impact physical activity within the dog's capabilities is important for overall health and metabolism:

Short, controlled walks
Passive range of motion exercises

**Key Principles of DM Rehabilitation Programs:**

Individualization:
Gradual progression:
Consistency:
Owner's participation:
Monitoring and adjustment:
Multidisciplinary approach:

**Benefits of Physical Rehabilitation in DM:**

Maintaining mobility and independence for longer.
Strengthening muscles to compensate for neurological weakness.
Improved proprioception and coordination.
Prevention or delay of secondary complications such as contractures, muscle atrophy due to disuse, and pressure ulcers.

Relief from pain or secondary discomfort.
Improving the dog's quality of life and reducing owner stress.

**Platelet-Rich Plasma (PRP) and its Regenerative Potential in the Nervous System:**
Platelet-rich plasma (PRP) is an autologous fraction of blood plasma containing a significantly higher concentration of platelets than that found in normal peripheral blood (8). These concentrated platelets are a rich source of various growth factors and other bioactive proteins that play a fundamental role in healing, tissue regeneration, and inflammation modulation (15).

**Obtaining and Composition of PRP:**
PRP is obtained from a sample of the patient's own blood (autologous) through centrifugation. This process separates the blood components, allowing for the collection of a platelet-enriched plasma fraction. The exact composition of PRP can vary depending on the preparation protocol, the equipment used, and the patient's characteristics (15) (16). In our case, the technique we developed allows us to obtain a hyperconcentrated concentration of platelets in plasma:

**High platelet concentrations:** Generally, between 20 to 35 times the normal concentration of platelets in the blood.

**Growth factors:** Released by activated platelets (17), these include:

**Platelet-derived growth factor (PDGF):** Stimulates the proliferation and migration of fibroblasts, endothelial cells, and smooth muscle cells; promotes angiogenesis and extracellular matrix synthesis.

**Transforming Growth Factor beta (TGF-β):** Regulates cell proliferation and differentiation, extracellular matrix synthesis, and has immunomodulatory effects.

**Epidermal Growth Factor (EGF):** Stimulates the proliferation and differentiation of epithelial and endothelial cells, and promotes angiogenesis.

**Vascular Endothelial Growth Factor (VEGF):** Induces angiogenesis (formation of new blood vessels) and increases vascular permeability.

**Nerve Growth Factor (NGF):** Promotes the survival, growth and differentiation of neurons.

**Brain-derived neurotrophic growth factor (BDNF):** Supports the survival, growth, and differentiation of neurons, and plays a role in synaptic plasticity.

**Insulin-like growth factor 1 (IGF-1):** Promotes cell survival and growth.

**Other bioactive proteins:** These include cytokines, chemokines, adhesion factors, and plasma proteins that contribute to the healing and regeneration process.

**Mechanism of Regenerative Action of PRP in the Nervous System:**
The regenerative potential of PRP in the nervous system is based on the local release of these growth factors and other bioactive molecules, which can influence various cellular and molecular processes crucial for neuronal repair and regeneration (18):

1. **Promoting Neuronal Survival (Neuroprotection):** Factors such as NGF and BDNF present in PRP can protect neurons from damage and apoptosis (programmed cell death) in settings of injury or degeneration. This is particularly relevant in DM, where axonal degeneration is a central process (19).
2. **Stimulation of Axonal Growth and Regeneration:** Neurotrophic factors such as NGF, BDNF, and IGF-1 can promote the growth and elongation of damaged axons. In DM, the regeneration of degenerated axons is a key therapeutic goal for restoring neurological function (19) (9).
3. **Angiogenesis and Improved Vascular Supply:** The VEGF present in PRP stimulates the formation of new blood vessels (angiogenesis). Improved vascularization can improve the supply of oxygen and nutrients to the damaged spinal cord, creating a more favorable environment for cell survival and regeneration (17) (20).
4. **Inflammation Modulation:** While inflammation is a necessary initial response to injury, chronic inflammation can be detrimental. PRP contains factors such as TGF-β that have immunomodulatory properties and can help regulate the inflammatory response, promoting a more favorable environment for tissue repair (17) (21) (22).
5. **Glial Cell Support:** Glial cells (astrocytes, oligodendrocytes, microglia) play a crucial role in the health and function of the nervous system. Factors released by PRP can influence the activity and differentiation of these cells, potentially supporting remyelination (restoration of the myelin sheath) and the removal of cellular debris (21).
6. **Stimulation of Progenitor Cell Proliferation and Differentiation:** The nervous system contains progenitor cells with the potential to differentiate into neurons and glial cells. The growth factors in PRP may stimulate the proliferation and differentiation of these cells, contributing to the regeneration of damaged tissue.

**Potential Effect of PRP as a Treatment for Canine Degenerative Myelopathy:**
Given the degenerative nature and lack of curative treatments for canine DM, PRP is emerging as a promising regenerative therapy that could address some of the underlying pathological mechanisms of the disease (8). PRP's ability to release neurotrophic factors, promote angiogenesis, modulate inflammation, and potentially stimulate axonal regeneration makes it an attractive candidate for research (23).

**Intramedullary infusion** of PRP, i.e., direct administration of PRP into the spinal cord, could offer significant advantages in the treatment of DM:

**Direct Delivery of Growth Factors:** Intramedullary infusion would allow a high concentration of growth factors directly at the site of degeneration, maximizing their bioavailability to target cells (22).

**Overcoming the Blood-Spinal Barrier:** The blood-spinal barrier limits the passage of many molecules from the systemic circulation to the central nervous system. Direct administration could bypass this barrier, ensuring a therapeutic concentration of PRP in the spinal cord (24).

**Potential for Localized Axonal Regeneration:** By administering PRP directly into the affected region of the spinal cord, regeneration of degenerated axons in areas critical for motor and proprioceptive function could be stimulated (18).

However, it is crucial to recognize that the use of PRP in canine DM, especially through intramedullary infusion, is still in the early stages of research. Specific scientific evidence in canines with DM is limited, and further well-designed preclinical and clinical studies are needed to evaluate its safety and efficacy.

**Preparation of Hyperconcentrated PRP:**

**Obtaining the Blood Sample:**
**Aseptic Technique:** Blood collection must be performed under strict aseptic conditions to minimize the risk of bacterial contamination. This includes proper preparation of the puncture site (trichotomy, disinfection, surgical drape, etc.), the use of sterile gloves, and disposable materials.

**Blood Volume:** The volume of blood to be extracted will depend on the PRP system used and the desired final concentration. It is crucial to calculate the volume needed to obtain the amount of PRP required for intramedullary infusion, taking into account losses during processing.

**Anticoagulant:** Blood must be collected in sterile tubes containing a suitable anticoagulant to prevent clotting during processing. Citric acid, sodium citrate dextrose (SCD), is the recommended anticoagulant for the preparation of PRP hyperconcentrate.

**Processing by Centrifugation:**
**Specific Protocol:** Processing blood by centrifugation is the critical step for separating components and concentrating platelets. It is essential to strictly follow the protocol recommended by the manufacturer of the PRP system used. Different systems may require different speeds, times, and number of centrifugations to optimize platelet concentration (25) (26).

**Quality Control:** Ideally, quality control of the obtained PRP should be performed to evaluate platelet concentration using a hematology counter. This ensures that the desired concentration (hyperconcentration) has been achieved (26).

**Sterile Environment:** The entire blood and PRP handling process must be carried out in a sterile environment, preferably under a laminar flow hood, to prevent contamination.

**Application of Hyperconcentrated PRP by Intramedullary Infusion:**
Intramedullary PRP infusion is an invasive procedure that requires careful surgical planning and precise technique to minimize the risk of neurological complications (27).

**Patient Preparation:**
**Complete Neurological Evaluation:** Prior to the procedure, a comprehensive neurological evaluation should be performed to document the patient's baseline status and determine the region of the spinal cord to which the infusion will be directed (28) (14).

**Confirmed Diagnosis:** The diagnosis of Degenerative Myelopathy must be confirmed by clinical history, neurological examination, exclusion of other causes, and ideally, SOD1 genetic testing (1).

**General Anesthesia:** The intramedullary infusion procedure requires general anesthesia to immobilize the patient and ensure comfort. Safe anesthesia protocols must be used, and the patient must be monitored throughout the procedure (8).

**Surgical Site Preparation:** Extensive sterile surgical preparation of the spinal area where the puncture will be performed must be performed. This includes shaving, surgical scrubbing with chlorhexidine or iodine, and sterile draping.

**Intramedullary Infusion Technique:**

**Image Guidance (Recommended):** Intramedullary infusion should ideally be performed under image guidance, such as live fluoroscopy or intraoperative ultrasound, to ensure accurate needle placement within the spinal canal and minimize the risk of damage to the spinal cord (29).

**Slow, Controlled Infusion:** Hyperconcentrated PRP should be infused slowly and at a controlled volume to avoid increased intramedullary pressure and tissue damage. Infusion pumps can be used to ensure accurate administration (27).

**Biosecurity During Application:**

**Sterile Equipment:** All equipment used during the infusion (needles, syringes, catheters, etc.) must be sterile and single-use.

**Sterile Gloves and Clothing:** Surgical personnel must wear sterile gloves, gowns, and drapes throughout the procedure.

**Safe Handling of Biological Fluids:** Safe protocols must be followed for the handling and disposal of unused blood and PRP.

**Discussion:**

Degenerative myelopathy (DM) is a progressive and incurable neurodegenerative disease affecting canines, primarily associated with a mutation in the SOD1 gene. This genetic alteration causes degeneration of the white matter of the spinal cord, with the consequent progressive loss of motor and proprioceptive function. Conventional treatments, such as corticosteroids, vitamins, and supplements, have shown limited efficacy or are controversial in terms of their impact on disease progression. While physical therapy and rehabilitation represent key tools for preserving mobility and improving quality of life, they are unable to halt the underlying neurodegenerative progression. In this context, it is essential to continue exploring innovative therapies, such as the use of platelet-rich plasma, which could offer new perspectives in axonal regeneration and the comprehensive management of this pathology.

Platelet-rich plasma (PRP) is emerging as a promising regenerative therapy due to its rich composition of growth factors and other bioactive proteins with neuroprotective, angiogenic, immunomodulatory, and axonal regeneration-stimulating potential. Intramedullary infusion of PRP could offer significant advantages by directly delivering these factors to the site of spinal cord injury, bypassing the blood-spinal barrier and maximizing their effect. Local release of these factors through intramedullary infusion could theoretically:

**Promote the survival of neurons and axons** that have not yet completely degenerated, providing a neuroprotective effect.
**Stimulate angiogenesis**, improving the supply of nutrients and oxygen to damaged areas, crucial for cell viability and repair.
**Modulate the chronic inflammatory response** associated with DM, creating a more favorable environment for regeneration.
**Potentially stimulate axonal regeneration** of damaged neurons, although this is a complex process and the magnitude of regeneration in the central nervous system is an area of intense research.

**Influence the activity of glial cells**, such as oligodendrocytes, which are important for myelination.

Although specific scientific evidence regarding intramedullary PRP infusion in canines with DM is currently limited, studies in animal models of spinal cord injury and other neurodegenerative diseases suggest that PRP may have regenerative and neuroprotective effects. Direct application to the spinal cord could enhance these effects by achieving therapeutic concentrations at the site of degeneration.

This *inherent limitation of current therapies* underscores the *urgent need to explore and develop new therapeutic strategies***.** that target the fundamental pathological mechanisms of DM. Regenerative therapy with PRP, administered directly to the spinal cord, represents an *innovative approach that could overcome these limitations***.** by attempting to influence the biology of degeneration and potentially promote nerve tissue repair.

**Corollary:**
Canine degenerative myelopathy (DM) remains a progressive and incurable neurological disease that significantly impacts the quality of life of affected dogs and represents a challenge for veterinarians. Current conventional treatments focus primarily on symptomatic management and have not been shown to substantially alter the degenerative course of the disease. This limitation underscores the urgent need to explore innovative therapies that may offer new hope for the treatment of DM.

Platelet-rich plasma (PRP), with its rich composition of growth factors and bioactive proteins, is emerging as a promising regenerative therapy strategy in veterinary medicine. Its potential to promote neuroprotection, angiogenesis, inflammation modulation, and, crucially, axonal regeneration, makes it an attractive candidate for the treatment of neurodegenerative diseases such as DM.

Although specific scientific evidence regarding intramedullary PRP infusion in canines with DM is currently limited, studies in animal models of spinal cord injury and other neurodegenerative diseases suggest that PRP may have regenerative and neuroprotective effects. Direct application to the spinal cord could enhance these effects by achieving therapeutic concentrations at the site of degeneration.

Intramedullary PRP infusion represents an innovative administration route that could maximize therapeutic benefits by directly delivering a high concentration of growth factors to the site of degeneration in the spinal cord, overcoming the limitations of the blood-spinal barrier. While specific scientific evidence on the application of this technique in canines with DM is still incipient, studies in animal models of spinal cord injury and other neurological diseases suggest significant regenerative potential of PRP in the nervous system.

**Challenges and Future Directions:**

The application of intramedullary PRP infusion as a therapy for canine DM faces several challenges that need to be addressed in future research:

**Specific Preclinical Scientific Evidence:** Rigorous preclinical studies in animal models that mimic aspects of DM or in canine spinal cord injury models are needed to evaluate the safety, technical feasibility, and potential benefits of intramedullary PRP infusion in terms of axonal regeneration, neuronal preservation, and functional improvement.

**Controlled Clinical Studies:** Once safety and potential efficacy have been established in preclinical studies, well-designed, controlled clinical trials in dogs with DM will be necessary to evaluate the true clinical efficacy of intramedullary PRP infusion in slowing disease progression, improving clinical signs, and improving quality of life. These studies should include appropriate control groups and objective endpoints.

**PRP Protocols and Optimal Infusion Techniques:** Research is needed to determine the optimal PRP preparation protocols (platelet concentration, activation or non-activation), the safest and most effective intramedullary infusion techniques (volume, rate, number of infusion sites), and the frequency of administrations.

**Long-Term Biosafety Considerations:** Potential long-term side effects of intramedullary PRP infusion into the canine spinal cord should be evaluated.

Ultimately, the search for effective therapies for canine degenerative myelopathy is an active and crucial area of research. Exploring the regenerative potential of PRP through intramedullary infusion represents a promising way that, with rigorous and ethical research, could offer new hope for the management of this devastating disease and improve the well-being of our canine patients. The scientific and veterinary community is encouraged to continue researching and developing innovative therapeutic approaches to address this unmet clinical need.

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