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Radiological evaluation of spondylosis deformans in the lumbar and lumbosacral vertebrae of dogs: breed, age, and gender associations

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Abstract
Spondylosis deformans (SD) is a common form of degenerative spinal disease in dogs, characterized by osseous bridging between vertebral bodies. This study focused on the lumbar and lumbosacral regions of the spine and analyzed radiographic records of 35 dogs of various breeds and age groups over a 12-month period. Computed tomography (CT) was selectively employed in cases where radiographic interpretation was inconclusive. The objective was to determine lesion localization and assess associations with breed, age, and gender. Findings showed that German Shepherds were most frequently diagnosed with SD, followed by Labrador Retrievers and mixed-breed dogs. Age distribution indicated that no cases were observed in dogs aged 1-2 years, while the highest prevalence occurred in the 7-10-year age group. Lesion localization data revealed that the L4-L6 region was most commonly affected. These results highlight the age-related progression of SD and its predilection for the lumbar spine, offering valuable insights for clinical assessment and management in veterinary practice.

Key words: Spine, spondylosis deformans, dogs, radiology, computed tomography.

Evaluación radiológica de la espondilosis deformante en las vértebras lumbares y lumbosacrales de los perros: asociaciones con la raza, la edad y el sexo

Resumen: La espondilosis deformante (ED) es una forma prevalente de enfermedad degenerativa de la columna vertebral en perros, caracterizada por la formación de puentes óseos entre los cuerpos vertebrales. Este estudio se centró en las regiones lumbar y lumbosacra de la columna vertebral y analizó registros radiográficos de 35 perros de diferentes razas y grupos etarios durante un período de 12 meses. La tomografía computarizada (TC) se utilizó de manera selectiva en los casos en que la interpretación radiográfica no fue concluyente, con el objetivo de evaluar la localización, así como la distribución por raza, edad y sexo donde la espondilosis deformante fue detectada. Los resultados mostraron que los Pastores Alemanes fueron los más frecuentemente diagnosticados, seguidos por los Labradores Retriever y los perros mestizos. La distribución por edad reveló que la ED estuvo ausente en perros de 1 a 2 años, pero fue más común en el grupo de 7 a 10 años. Los datos de localización indicaron que la región L4–L6 fue la más frecuentemente afectada. Estos resultados subrayan la naturaleza relacionada con la edad de la ED y su asociación con la columna lumbar, proporcionando información esencial para la práctica veterinaria.

Palabras clave: Columna vertebral, espondilosis deformante, perros, radiología, tomografía computarizada.

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INTRODUCTION

Deforming spondylosis is a condition of the vertebrae that is observed in domestic animals, particularly dogs and cats (Kranenburg et al. 2012, Togni et al. 2014), as well as in wild species such as coyotes and bears (Duckler 1997, Wagner et al. 2005), and even in fossil fauna, including Pleistocene sloths and Glyptodonts (Barbosa et al. 2019, Vicencio Campos et al. 2024). It is the most common form of degenerative spinal disease, characterized by partial or complete osseous bridging between vertebral bodies (Park et al. 2024). Spondylosis is described as a non-inflammatory, degenerative disease affecting the region peripheral to the endplate, characterized by new bone formation originating several millimeters from the disco-vertebral junction. These changes often appear on the ventral and lateral surfaces of the vertebral bodies, with significantly less frequency on the dorsal surfaces (Thomas and Fingeroth 2015). Osteophytes can range from small spurs to bony bridges spanning the disc space, while the majority of the ventral surface of the vertebral body remains unaffected (Kranenburg et al. 2014). In dogs, the lumbar vertebrae, or the lower back region near the hips, are the most commonly affected areas. The pattern of spondylotic changes can vary, with ossification starting from one vertebra and progressing to the adjacent one, initiating simultaneously on both adjacent vertebrae and merging in the middle, beginning centrally between two vertebrae and advancing in both directions, or developing as a combination of these variations. In severe cases, spondylosis can result in complete spinal fusion. This condition leads to non-inflammatory and permanent damage to the spine, potentially resulting in a loss of function and mobility issues (Karina and Arjentinia 2023).

Through a detailed clinical examination of these patients, body stiffness in the affected spinal region can be detected. Clinical signs associated with severe canine spondylosis, besides back stiffness include lameness, altered gait, and pain. Working dogs may be particularly affected by spondylosis, as it has been suggested to reduce spinal mobility. In working dogs, reduced spinal flexibility is noted to restrict their activity (Hadžijunuzović-Alagić and Hadžimusić 2024). Although in most cases, spondylosis is not considered clinically significant. Certain mechanical movement impairments may occur, although spondylosis generally progresses without clinical signs. However, in some instances, it may lead to nerve root compression at the level of the intervertebral foramina. In some cases, secondary complications such as narrowing of the intervertebral space can arise, though disc prolapse is uncommon in most cases. Conversely, spondylosis may develop as a secondary consequence of chronic disc prolapse (Bureš et al. 2022). Differentiation between these conditions can be based on the extent of spondylotic changes. If only one intervertebral space is affected without spondylotic changes elsewhere, the condition likely represents primary disc degeneration with secondary spondylosis. Conversely, if diffuse spondylotic changes are evident across the spine with only a single narrowed intervertebral space, the condition typically indicates primary spondylosis deformans with secondary disc degeneration. If clinical signs of these changes occur, myelography should be performed to determine disc prolapse (Burk and Feeney 2003, Hadžijunuzović-Alagić and Hadžimusić 2024). Arthritis of the articular surfaces of the spine can lead to the formation of periarticular osteophytes and irregularities of the articular surfaces, resulting in the loss of the normal joint space. The true clinical significance of such radiographic changes is unknown; however, if present in a severe form, it can cause back pain. In rare cases, osteophytes can grow large enough to protrude toward the spinal cord or nerve roots, while another complication may involve the development of a synovial cyst from chronically inflamed joint capsules. Such cysts can form in the extradural space and compress the spinal cord. On myelography, a dorsal solitary or bilateral extradural mass is typically seen (Perez et al. 2000). Spondylosis is classified based on its location, including cervical spondylosis, cervicothoracic spondylosis, thoracic spondylosis, thoracolumbar spondylosis, lumbar spondylosis, and lumbosacral spondylosis.

Canine spondylosis is often diagnosed through radiographic examination and/or histopathological analysis. Disease progresses through the gradual calcification of the ventral longitudinal ligament, which appears on X-ray images as enthesophytes extending from the edges of the vertebrae (Halle and Granhus 2021). Spondylosis primarily affects older medium to large breed dogs; however, changes can be observed during necropsy in individuals as young as six months of age (Morgan et al. 1989). The prevalence of canine spondylosis rises with age, and a higher prevalence has been noted in Boxers (Carnier et al. 2004).

Spondylosis deformans is prevalent not only in dogs but also in humans (Kranenburg et al. 2014). The condition is often used as a model for human disease in dogs, which further underscores the importance of studying this disease in canines (Lee et al. 2020). Similar to spondylosis in humans, the precise mechanism is not fully understood, but it is believed to be predominantly caused by age-related degeneration of the peripheral annulus fibers (Park et al. 2024).

The objective of this study was to evaluate the radiological characteristics of spondylosis deformans in the lumbar and lumbosacral spine of dogs and to analyze its distribution in relation to breed, age, and gender. Additionally, we aimed to identify the most commonly affected spinal segments and provide insight into the clinical relevance of these findings.

MATERIAL AND METHODS

Study design and case selection. This retrospective descriptive study was conducted over a 12-month period and included 35 dogs presented to the Veterinary Faculty, University of Sarajevo, for spinal imaging. Dogs were included in the study based on the following inclusion criteria:

- Availability of complete radiographic records of the lumbar and/or lumbosacral spine.
- Clinical or radiographic suspicion of spondylosis deformans (SD).
- No evidence of spinal trauma, neoplasia, or congenital malformations.

Cases were excluded if the imaging documentation was incomplete or if spondylotic changes were absent.

Imaging protocol and diagnostic criteria. All included dogs underwent native radiographic examinations, which involved standard left lateral (LL) and ventrodorsal (VD) projections of the lumbar and lumbosacral spine. Computed tomography (CT) was not performed uniformly, but was used selectively in cases where the radiographic findings were inconclusive or when additional anatomical detail was required for confirmation. Scans were obtained using varying slice thicknesses and were evaluated using multiplanar reconstruction (MPR) and 3D rendering where needed. Deforming spondylosis of the lumbar and lumbosacral spine in dogs is radiographically recognized by bone proliferations (osteophytes), narrowing of the intervertebral space, and calcification of the intervertebral disc (Togni et al. 2014).

Breed, age, and gender classification. Dogs were categorized by breed and further grouped into two size-based categories, as proposed by Breit (2002) with German Shepherds, Belgian Shepherds, Dobermans, Labrador Retrievers, Irish Setters, and mixed breeds classified as large breeds, and Dachshunds and Pekingese classified as small breeds. For the analysis of SD, dog breeds were divided into small and large breeds (Breit 2002). Large breeds included German Shepherds, Belgian Shepherds, Dobermans, Labrador Retrievers, Irish Setters, and mixed breeds, while small breeds included Dachshunds and Pekingese. For age-based analysis, dogs were grouped into four categories: 1-2 years, 3-6 years, 7-10 years, and over 10 years. Additionally, the gender of each dog was recorded.

Localization of lesions. The localization of radiologically diagnosed changes was assessed for each breed, covering the T13-L3, L4-L6, and L7-S1 regions.

Statistical analysis. Descriptive statistics were used to summarize the distribution of spondylosis deformans according to breed, age, gender, and lesion location.

To assess the association between age and the prevalence of SD, dogs were grouped into two broader categories (≤6 years vs. >6 years). The difference in proportions was evaluated using a chi-square (χ^2) test, with a significance level of $\alpha = 0.05$ and corresponding 95% confidence intervals calculated. The statistical analysis was conducted in Microsoft Excel and manually verified.

Given the limited sample size, no multivariate statistical models were applied, and the results are interpreted descriptively with caution.

RESULTS AND DISCUSSION

The results are presented in tables. As shown in Table 1, German Shepherds were the most commonly affected breed, followed by Labrador Retrievers and mixed-breed dogs.

Table 1. Breed and Gender of dogs with spondylosis deformans (SD).

Breed	Males (%)	Females (%)	Total (%)
German Shepherd (n = 10)	17.14	11.43	28.57
Belgian Shepherd (n = 2)	2.86	2.86	5.71
Doberman (n = 2)	5.71	0.00	5.71
Labrador Retriever (n = 8)	11.43	11.43	22.86
Irish Setter (n = 1)	2.86	0.00	2.86
Dachshund (n = 2)	0.00	5.71	5.71
Pekingese (n = 2)	2.86	2.86	5.71
Mixed breed (n = 8)	8.57	14.29	22.86
Total (n = 35)	51.43	48.58	100

Table 2 illustrates that the majority of SD cases were found in dogs aged 7-10 years, with no diagnoses in dogs under two years of age.

The majority of cases were found in German Shepherds, followed by Labrador Retrievers and mixed-breed dogs. In terms of gender distribution, 18 diagnosed cases were recorded in males and 17 in females.

Table 2. Breed and age distribution of dogs with spondylosis deformans (SD).

Breed	Age: 3-6 years (%)	Age: 7-10 years (%)	Age: >10 years (%)	Total (%)
German Shepherd (n = 10)	2.86	17.14	8.57	28.57
Belgian Shepherd (n = 2)	0.00	5.71	0.00	5.71
Doberman (n = 2)	2.86	2.86	0.00	5.71
Labrador Retriever (n = 8)	5.71	11.43	5.71	22.86
Irish Setter (n = 1)	0.00	2.86	0.00	2.86
Dachshund (n = 2)	2.86	2.86	0.00	5.71
Pekingese (n = 2)	0.00	2.86	2.86	5.71
Mixed breed (n = 8)	5.71	11.43	5.71	22.86
Total (n = 35)	20.00	57.15	22.85	100.00

Regarding age distribution, no cases were diagnosed in the 1-2-year age group. The majority of dogs diagnosed with SD were in the 7-10-year age group. Specifically, seven cases were observed in dogs aged 3-6 years, and eight cases were found in dogs older than 10 years.

As shown in Table 3, the majority of SD were diagnosed in the L4-L6 segment of the lumbar spine, consistent across most breeds.

Table 3. Localization and frequency of spondylosis deformans (SD) in examined dog breeds.

Breed	Localization T13-L3 (%)	Localization L4-L6 (%)	Localization L7-S1 (%)	Total (%)
German Shepherd (n = 10)	2.86	14.29	11.43	28.57
Belgian Shepherd (n = 2)	0.00	2.86	2.86	5.71
Doberman (n = 2)	0.00	2.86	2.86	5.71
Labrador Retriever (n = 8)	5.71	11.43	5.71	22.86
Irish Setter (n = 1)	0.00	0.00	2.86	2.86
Dachshund (n = 2)	0.00	5.71	0.00	5.71
Pekingese (n = 2)	2.86	2.86	0.00	5.71
Mixed breed (n = 8)	8.57	8.57	5.71	22.86
Total (n = 35)	20.00	48.57	31.43	100.00

In Table 4, the results of the significance testing for the difference in proportions of spondylosis deformans (SD) cases in the lumbar and lumbosacral spine among dogs of different ages are presented for a total of 35 SD cases diagnosed in the studied population.

Table 4. Results of testing the difference in proportions of spondylosis deformans (SD) cases in the lumbar and lumbosacral spine among dogs of different ages for a total of 35 SD cases diagnosed in the studied population (chi-square test; $\alpha = 0.05$).

Age	SD-positive (n)	SD-positive (%)
6 years	7	20
Over 6 years	28	80
Total	35	100
Difference (%)	60	
95% Confidence Interval (%)	36.05 - 76.35	
Chi-square statistic	22.857	
Degrees of freedom (DF)	1	
P-value (two-sided)	<0.0001	

In the total of 35 SD cases diagnosed in our study, the proportion of SD cases in dogs over 6 years of age was statistically highly significant ($p<0.0001$) compared to the proportion of SD cases observed in dogs younger than 6 years.

Figures 1-6 illustrate specific features of spondylosis deformans, including narrowing of the intervertebral space and elongation of the sacral lamina into the caudal aperture of vertebra L7, bone proliferations, intervertebral space narrowing, bilateral stenosis.

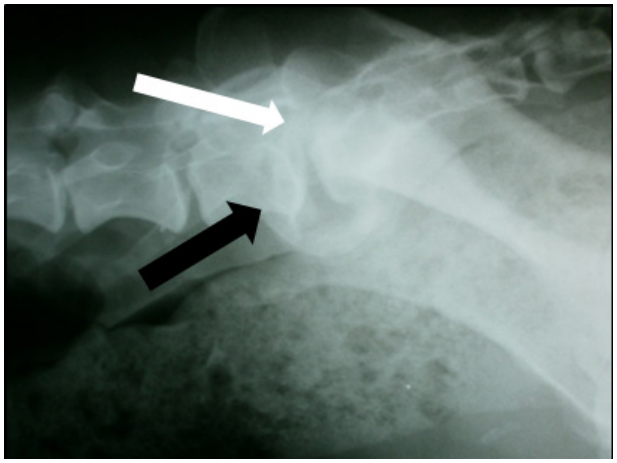

Figure 1. In the lateral projection of the lumbosacral region of the spine in a German Shepherd, ventral spondylosis is observed with narrowing of the intervertebral space (black arrow), as well as elongation of the sacral lamina into the caudal aperture of vertebra L7 (white arrow).

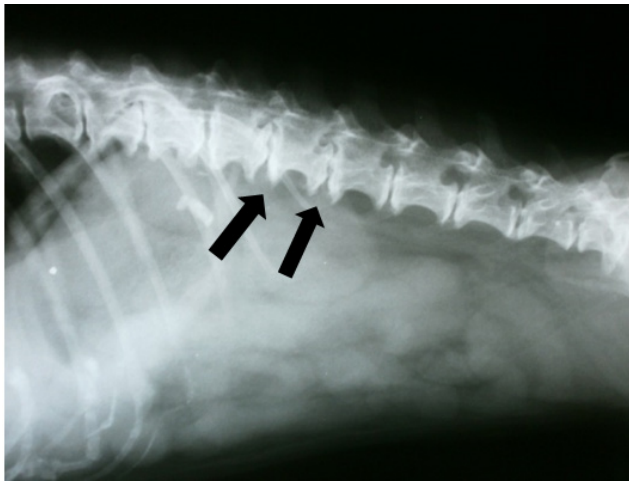

Figure 2. In the lateral view of the thoracolumbar region of the spine in mixed breed dogs, bony proliferations are prominent on the ventral edges. Narrowing of the intervertebral space is more pronounced between L1-L2-L3 (arrows).

This study provides insight into the distribution and radiological characteristics of spondylosis deformans (SD) in the lumbar and lumbosacral spine of dogs, with specific attention to breed, age, and gender. Our findings confirm previously reported trends that SD is more common in older dogs, particularly those over six years of age, and predominantly affects medium to large breeds such as German Shepherds and Labrador Retrievers. The relatively high proportion of mixed-breed dogs affected supports the notion that SD is not limited to purebred populations and

may be influenced by a combination of environmental and anatomical risk factors. The gender distribution of 35 cases of spondylosis deformans (SD) diagnosed in dogs of various breeds (Table 1) indicates that the disease was almost equally represented among males (51.43%) and females (48.57%). The proportion of SD cases diagnosed in large-breed dogs (n = 31; 88.57%) was significantly higher than that of small-breed dogs (n = 4; 11.43%). Large-breed dogs naturally have greater body mass, which places increased mechanical stress on their vertebral columns over time. This chronic mechanical loading accelerates degenerative changes in the spine, leading to the formation of osteophytes and the development of SD (Latham and Losey 2019). The diversity of age and breed distributions is shown in Table 2. These results show that the overall occurrence of SD was most frequent in the age group of 7-10 years (57.14%), less frequent in dogs older than 10 years (22.86%) and middle-aged dogs (3-6 years; 20%), with no SD cases diagnosed in young dogs (1-2 years). The absence of cases in the youngest age group (1-2 years) and peak frequency in dogs aged 7-10 years suggest a progressive pathophysiological process likely driven by biomechanical stress, aging of spinal tissues, and possibly genetic predisposition. SD-related changes were localized in the L4-S1 vertebral region in 80% of cases, while only 7 cases (20%) were diagnosed in the T13-L3 segment (Table 3).

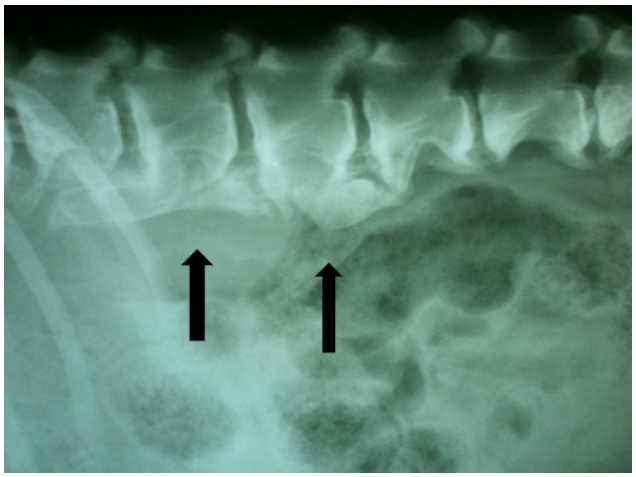

Figure 3. The radiograph in the lateral view of the lumbar spine in a Labrador Retriever reveals prominent ankylosing spondylosis and spondyloarthrosis (arrows).

Studies indicate that spondylosis deformans most frequently occur in the thoracolumbar and lumbosacral regions of the vertebral column, with the intervertebral disc spaces between the second and third lumbar vertebrae (L2-L3) and between the seventh lumbar and first sacral vertebrae (L7-S1) being the most commonly affected (Ortega et al. 2012). In German Shepherds, an irregular facet geometry of the seventh lumbar vertebra (L7) has been shown to contribute to a predisposition to spondylosis. Additionally, congenital factors, body weight, and the locomotion of immature dogs may also play a role in predisposing them to the condition (Breit and Künzel 2001). Our results indicate that among all diagnosed cases of SD in the lumbar and lumbosacral spine (n = 35), there were more cases in older dogs than in younger ones (Table 4). The proportion of SD cases in dogs over six years old (n = 28; 80%) was statistically significantly higher ($p<0.0001$) than the proportion in dogs

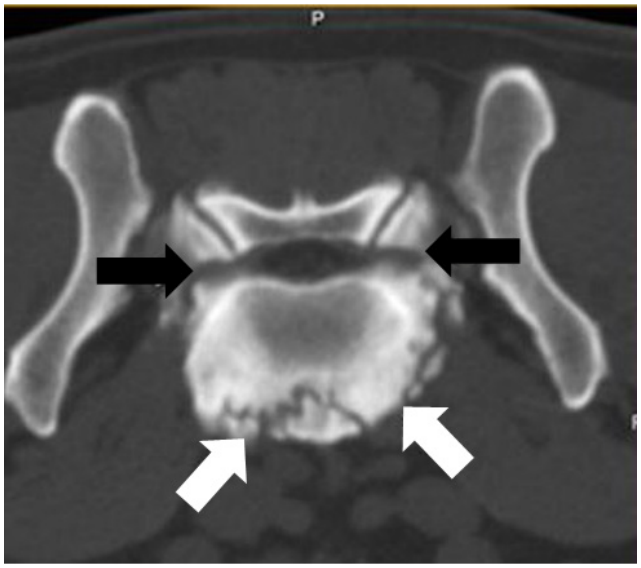

Figure 4. Axial tomogram of a Doberman shows bilateral bony proliferations that largely occlude the intervertebral foramina (black arrows). Prominent bony proliferations are observed ventrally on the body of the seventh lumbar vertebra (white arrows).

younger than six years (n = 7; 20%). These findings support previous studies reporting a higher prevalence of SD in older dogs (Morgan 1967a,b, Morgan et al. 1967, 1989, Carnier et al. 2004, Kranenburg et al. 2011). Additionally, Morgan (1967a,b) and Morgan et al. (1967, 1989) also describe breed predisposition, particularly the frequent occurrence of SD in German Shepherds. According to some studies, Boxers and German Shepherds appear to be predisposed to this condition (Ortega et al. 2012). An early study on spondylosis in Boxers from the USA, UK, and Sweden reported the disease in approximately 50% of dogs by the age of six and in 75% by the age of nine. A comparable prevalence was observed in a subsequent study of Italian Boxers (Halle and Granhus 2021). Our results (Table 1) show that of the total 35 SD cases, nearly 29% were diagnosed in German Shepherds. In our research, 80% of SD cases were localized in the L4-S1 vertebral region, whereas in the aforementioned study, the most commonly affected spinal segments were L2-L4 and L7-S1. In our study, 57.14% of SD cases fell within the 7-10-year age group, while 22.86% of spondylosis cases involved dogs older than ten years.

The study highlights the significant prevalence of spondylosis deformans in medium to large breed dogs, particularly in those aged over 6 years, with a predominant occurrence in the L4-L6 region. Radiographic and CT imaging remain crucial for diagnosing and assessing the extent of spondylosis. This research reinforces the importance of early detection and monitoring in older dogs to manage potential functional impacts. A limitation of this study is the selective use of CT imaging, which was applied only in a subset of cases where radiographic diagnosis was uncertain. While CT findings provided valuable anatomical insight in individual patients, their non-uniform application may introduce variability and limit the comparability of imaging data across the study population. Consequently, CT results were not included in statistical analysis, and their role was restricted to descriptive support of radiographic interpretations.

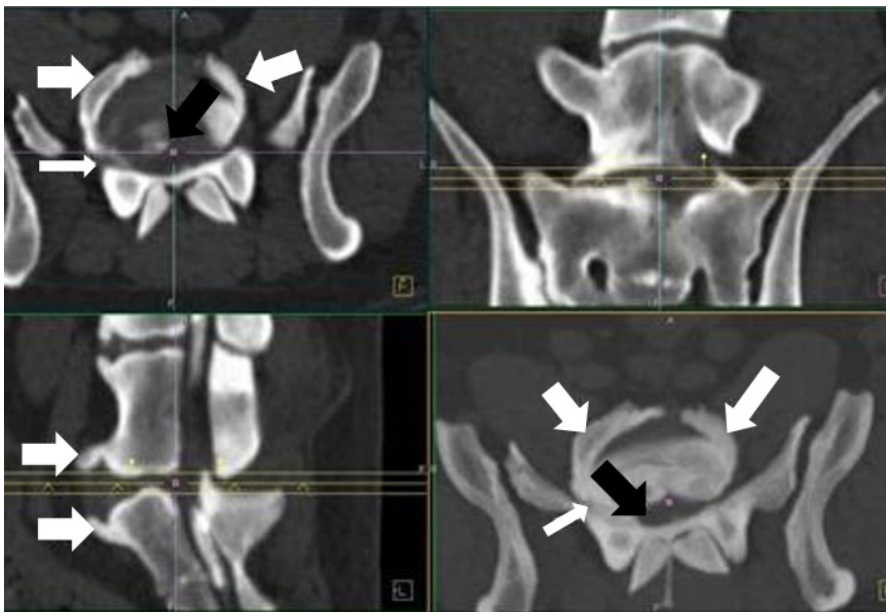

Figure 5. Multiplanar MIP reconstruction of the lumbosacral segment of the spine in a German Shepherd. The thicker white arrows indicate severe changes of DS, while the black arrows point to degeneration of the L7-S1 intervertebral disc. In the transverse sections of the 6 mm wide intervertebral space (upper left and lower right), a dorsal protrusion of the degenerated disc is highlighted, resulting in attenuation of the vertebral canal (black arrows). Bilateral attenuation of the intervertebral foramina is also visible (thinner white arrows).

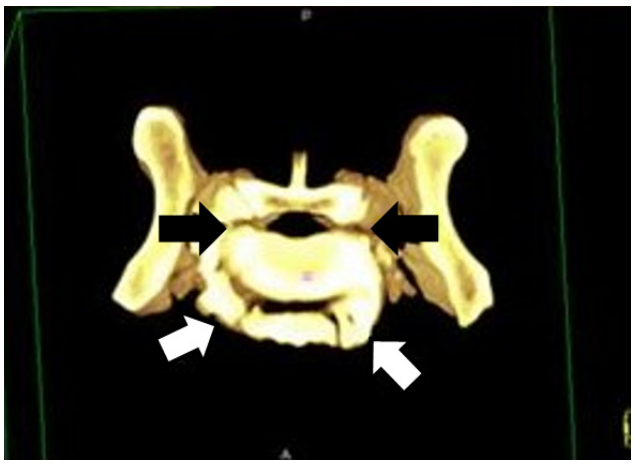

Figure 6. Transverse VR reconstruction of the lumbosacral junction in a mixed-breed dog. Bilateral stenosis of the L7-S1 intervertebral foramina (black arrows) and abundant ventral bony proliferations (white arrows) are clearly visible.

Despite these limitations, our findings contribute to a better understanding of the epidemiological and anatomical patterns of spondylosis deformans in dogs. They highlight the importance of early recognition in predisposed breeds and age groups, and the utility of radiological evaluation in clinical practice. Further studies with larger sample sizes and longitudinal follow-ups are warranted to better understand the progression and long-term implications of spondylosis in canine patients.

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