

RADIOLOGICAL COMPARISON OF LUMBOSACRAL ANATOMY BETWEEN GERMAN AND BELGIAN SHEPHERD (MALINOIS) WORKING DOGS

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Summary: The objective of this study was to assess the radiologic differences and the incidence of clinical and radiological signs of degenerative lumbosacral stenosis (DLSS) in 36 active working dogs; 24 German Shepherd (GSDs) and 12 Belgian Shepherd (Malinois; MNs). The medical record was evaluated and pertinent historical data recorded. Thorough clinical and neurological examinations were performed, as well as plain and contrast radiography (myelography) of caudal lumbar and sacral vertebrae. Thirty-three (92%) dogs were able to perform their duties without restrictions. Three (8%) dogs were excluded from active duty due to DLSS (2 dogs) or thoracolumbar disc disease (1 dog). Sixteen GSDs showed clinical signs of DLSS, and the most consistent finding was lower back pain (15 of 16; 94%). Radiological signs of DLSS were confirmed in 10 of them. The differences between GSDs and MNs were found in the bodyweight (GSDs>MNs; $p<0.001$) and anatomical conformation of the lumbosacral area, which was correlated with the incidence of DLSS. GSDs had significantly higher bodies of L7 ($p<0.001$) and S1 ($p<0.01$), higher L7/S1 step ($p<0.01$) and shorter CrS1/SL distance ($p<0.05$) than MNs. There was a significant association between DLSS and spondylosis deformans ($p<0.05$) and sclerosis of S1 cranial endplate ($p<0.05$). In MNs, no dog was radiographically confirmed for DLSS, although the age of dogs of both breeds was comparable. Fewer eventual radiological changes of the lumbosacral spine were also found in MNs. Regarding our findings, MNs seem to be more suitable for working dogs. The limitations of our study are the small number of MNs and the lack of MNs with DLSS. Our study confirmed radiographic differences of the lumbosacral junction between GSDs and MNs. Nevertheless, we could not confirm any radiographic parameter as a predisposing sign.

Key words: lumbosacral junction; radiography; myelography; working dogs; German Shepherd dogs; Belgian Shepherd dogs (Malinois); degenerative lumbosacral stenosis

Introduction

Cauda equina syndrome (CES) refers to a complex of clinical signs resulting from compression of cauda equina nerve roots. Degenerative lumbosacral stenosis (DLSS) is the most common cause of cauda equine syndrome reported in working dogs. German Shepherd dogs (GSDs) are the most commonly affected by clinical signs related to DLSS (1, 2, 3, 4, 5, 6, 7, 8, 9). To

our knowledge there is no data published about incidence of DLSS in MNs. DLSS is the most common abnormality of the LS junction in dogs, particularly working GSDs (4, 6, 8, 9, 10). It is a multifactorial degenerative disorder resulting in stenosis of the spinal canal and compression of the cauda equina or its blood supply (4, 6, 8). Spinal cord diseases and CES in particular are common causes for early exclusion of working dogs (11, 12, 13).

The most common and typically earliest finding in dogs with DLSS is pain during palpation and hyperextension of the LS junction (10). The clinical

signs of dogs that are affected by DLSS may show considerable variation related to the severity of compression of the cauda equina. The most common clinical signs are pelvic limbs lameness, abnormal gait, and caudal lumbar pain (3, 4, 5). Each dog can have one or more clinical signs.

Diagnosis is based on history, clinical and neurological assessment and the correlation of clinical findings and ancillary diagnostic imaging findings. Radiography, stress radiography and contrast studies (myelography, epidurography) may aid in ruling out pathological osseous changes of the LS region as cause of CES (14, 15, 16). Myelography represents a useful technique for assessing stenotic lesions in the lumbar spinal canal as well as detection of DLSS when a dural sac extends into the sacrum. The diagnostic sensitivity of myelography may be enhanced by using flexion-extension myelography of the lumbosacral junction (17)»=B.

Slovenian police GSDs and MNs are examined radiographically for hip and elbow dysplasia before accepted to working unit (18). To our knowledge, there are no published data elsewhere in the world regarding working dogs being regularly evaluated for spinal changes in lateral projection of the spine (ie. lumbal transitional vertebra (LTV), evaluation of LS conformation) before acceptance to the working unit.

The aim of this study was to radiographically assess LS area in working police GSDs and MNs and compare the radiographic (myelography) and clinical findings of DLSS. This study also attempts to identify whether radiography of whole lumbar and sacral area in lateral projection before acceptance to the working unit is of clinical relevance.

Materials and methods

Animals

Thirty-six working police dogs, 35 intact males and 1 intact female, were included in the study. Twenty-four of them were GSDs and 12 MNs. Mean age of the examined dogs was 68.3 ± 33.5 months (76.6 ± 31.9 months in GSDs and 51.8 ± 31.3 months in MNs). All dogs were regularly used as patrol and attack dogs at a Slovenian police unit during the time of examination. The consent of the owner was obtained, and protocols were approved

by the Veterinary Administration of the Republic of Slovenia (No. 34401-25/2010/3).

Evaluation of the dogs consisted of the observation of a handler, clinical and neurological examination and native and contrast (myelography) radiography. Final diagnosis of DLSS was based on clinical signs of pain and myelographically confirmed compression of cauda equina. Compression was pronounced with extension and relieved with flexion. In this study, dogs were assigned into three groups based on a dog breed and confirmed lumbosacral stenosis, namely 1) GSDs without DLSS (GSD/NOrDLSS; $n=14$), 2) GSDs with DLSS (GSD/rDLSS; $n=10$) and 3) MNs without DLSS (MN/NOrDLSS; $n=12$).

Study protocol

Handlers were asked about the general health status of their dog and any concurrent disorders diagnosed by their veterinarian. They were also asked about their dog's performance of expected duties and if they noticed any signs of pain, lameness or weakness (especially of the pelvic limb and tail). Each dog underwent a neurological examination that included assessments of attitude, posture and gait outside the clinic. Later on, the quality of conscious proprioception, spinal reflexes, the anal and tail tone were assessed. Deep palpation, lumbosacral hyperextension and hyperextension of the tail were performed to evaluate lumbosacral hyperesthesia. A physical examination, including auscultation of the heart and lungs, palpation of the peripheral pulse and blood sampling for evaluation of general health status before anaesthesia was performed.

A pre-sedation complete blood count, white cell differential count, and serum biochemistry profile including blood urea nitrogen, creatinine, total protein, albumin, glucose, sodium, potassium, chloride, alkaline phosphatase and alanine aminotransferase (data not shown) were determined to exclude underlying diseases.

Radiography

Following the neurological examination all the dogs underwent survey and contrast radiography (myelography) under general anaesthesia. Dogs were premedicated with methadone (Heptanon; Pliva, Zagreb, Croatia) $0.28\text{--}0.3$ mg/kg

subcutaneously. General anaesthesia was induced with midazolam (Dormicum; F. Hoffmann-La Roche, Basel, Switzerland) 0.07-0.2 mg/kg and thiopental (Nesdonal, Merial, Lyon, France) 7.8-17.4 mg/kg given intravenously. After intubation with a cuffed endotracheal tube, anaesthesia was maintained with isoflurane (Forane; Abbott Laboratories, Baar, Switzerland) in 100 % oxygen, using a circle circuit. Radiographic images were taken by AXIOM Iconos R100, Siemens AG, Munich, Germany and films developed by CLASSIC E.O.S., Agfa, Munich, Germany.

First, a right lateral (RL) radiograph of the lumbosacral area with hind legs in a neutral position was obtained. After collecting cerebrospinal fluid (data not shown), a non-ionic contrast medium iohexol (Omnipaque 240 mgI/ml, Nycomed Inc, Princeton, NJ) 0.3-0.5ml/kg was injected into the subarachnoid space at the cisterna magna. Dogs were tilted at 15-20° with their heads up and the fluoroscopy/radiograph was taken immediately. When contrast reached the lumbosacral region, three more radiographs of the lumbosacral junction were obtained: 1) a RL with hind legs in neutral position, 2) a RL with hind legs in flexion, 3) a RL with hind legs in extension. In total, the radiographic examination included four lateral radiographs in three different positions. All radiographs were assessed by the same radiologist (BZ) for evidence of spondylosis, L7 and S1 endplate sclerosis, LTV and sacral osteochondrosis (SOC). The number of lumbar vertebra was counted in each dog in order to identify LTV (8 lumbar vertebra). Next, the ventral displacement of the sacrum in respect to L7, also named misalignment of L7 or L7/S1 step formation, was evaluated. It was defined as a distance between two lines: a first line was drawn along the dorsal aspect of the body of L7, and a second line, parallel to the first, was drawn at the height of the craniodorsal edge of the sacrum. The height of the caudal endplate of L7 and the cranial endplate of S1 were measured axially. At the same place, the height of the spinal canal at the level of L7 and S1 was measured, defined as L7/S1 spinal canal ratio. The extension of the dural sac over the lumbosacral junction was evaluated on contrast radiographs with hind legs in neutral position. All measured parameters are shown in Figure 1.

Cranially prolonged sacral lamina with or without sacral overhang could contribute to the compression of cauda equina, so the measurement

of CrS1/SL distance was also made between the cranial endplate of S1 and cranial extent of the sacral lamina(19), as shown in Figure 2.

Statistical analysis

Data were analysed with the commercial software SPSS 22.0. (Chicago, Illinois, USA). Descriptive statistics was used to describe the basic features of the data. The association of the all three dog groups with anatomical conformation of the LS region was examined using a χ^2 -square test. The difference between MN/NOrDLSS, GSD/NOrDLSS and GSD/rDLSS in body weight, vertebral body height of L7, vertebral body height of S1 and CrS1/SL distance was examined using a one-way ANOVA. Spinal canal height at L7, spinal canal height at S1 and L7/S1 misalignment were examined using a non-parametric Mann-Whitney U test. A Shapiro-Wilks test was used to test the normality. Statistical differences were considered significant with $p < 0.05$.

Results

History

Handlers of 12 of 36 (33%) dogs (11 GSDs and 1 MN) reported problems potentially associated with a lumbosacral disorder. These included mild lameness or occasional weakness of the pelvic limbs (10 dogs) difficulty jumping (6 dogs), and signs of lower back pain (4 dogs). Handlers of 33 of 36 (92%) dogs considered their dogs to be able to perform their duties without restrictions and 3 (all GSDs) dogs were reported to be on restricted duties (dogs were used as patrol dogs, but excluded from heavy attack training). Reason for restricted duty was DLSS in 2 dogs and thoracolumbar disc disease in 1 dog, all diagnosed previously.

Gait assessment

Of 36 dogs, posture and gait were normal in 20 (55%). Changes were seen intermittently in 8 (22%) dogs, persistent but mild changes (intermittent foot misplacement and toe knuckling, mild ataxia) were seen in 6 (17%) dogs, persistent and obvious (ataxia, uneven distribution of weight on the limbs, improper limb positioning, toe knuckling, occasional circling) changes in 2 (6%).

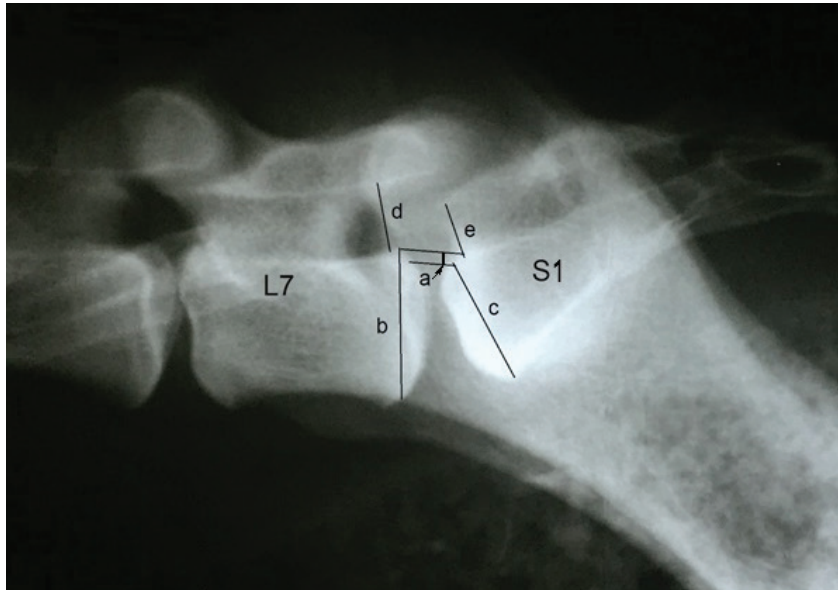


Figure 1: Schematic presentation of parameters of the lumbosacral junction measured on RL radiographs. L7- seventh lumbar vertebra; S1- first segment of sacrum; a- L7/S1 misalignment; b- L7 height; c- S1 height; d- spinal canal height L7; e- spinal canal height S1

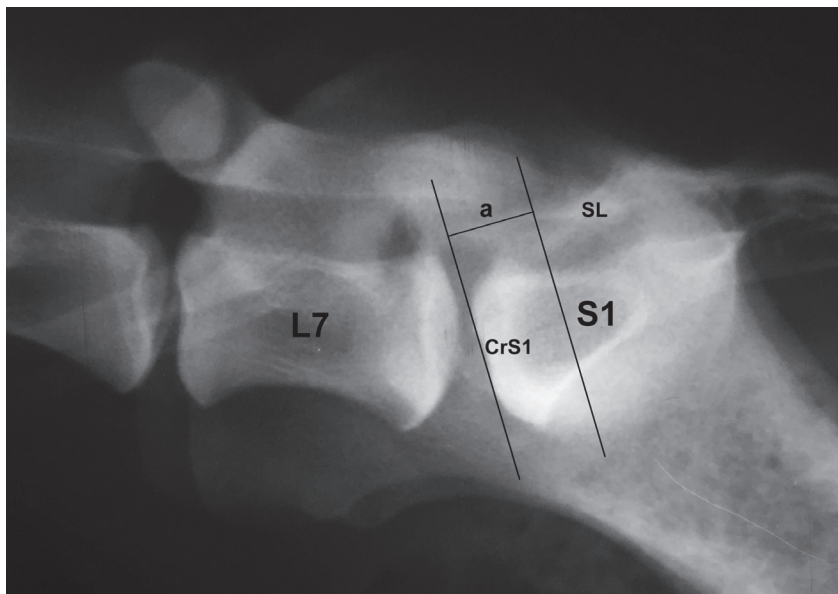


Figure 2: Schematic presentation of CrS1/SL distance on a RL radiograph. CrS1/SL distance (a) was defined as distance between the cranial endplate of sacrum (CrS1) and cranial point of sacral lamina (SL); L7- seventh lumbar vertebra; S1- first segment of sacrum

Clinical signs

Sixteen GSDs showed clinical signs of DLSS. On clinical exam, the most consistent finding was lower back pain (15 of 16), elicited by hyperextension of the lumbosacral junction (11 of 15; 2 GSD/NOrDLSS and 9 GSD/rDLSS), by digital palpation of the paraspinal muscles at the level of the lumbosacral joint (2 of 15) or by hyperextension of the tail (2 of 15). Digital palpation of paraspinal muscles was painful in 2 GSD/NOrDLSS and hyperextension of the tail was painful in two other GSD/NOrDLSS.

Neurological examination

The neurological exam was abnormal in 17 of 36 (47%) dogs, including 11 dogs with a history of pain or pelvic gait abnormalities. Abnormal findings included proprioception deficits (5 of 17; 2 GSD/NOrDLSS and 3 GSD/rDLSS), reduced withdrawal reflex (1 of 17; GSD/rDLSS) and gait abnormalities seen in 5 GSD/NOrDLSS and 5 GSD/rDLSS. Each dog could have one or more clinical signs. None of the MN/NOrDLSS showed any clinical abnormalities.

Table 1: Body weight and vertebral parameters at the level of L7-S1 in GSD/NOrDLSS, GSD/rDLSS and MN/NOrDLSS dogs. Data are presented as mean \pm S.E.M.

		GSD/NOrDLSS (n= 14)	GSD/rDLSS (n= 10)	MN/NOrDLSS (n= 12)
BW [kg]		37.5 \pm 1.2	36.0 \pm 1.2	31.2 \pm 0.8 ^a
L7/S1 misalignment [mm] (rate)		0.5 \pm 0.2	0.9 \pm 0.3	0.1 \pm 0.1 ^c
incidence of L7/S1 misalignment [%]		43	70	8
CrS1/SL distance [mm]		8.1 \pm 0.8	8.6 \pm 1.1	10.5 \pm 0.4 ^c
vertebral body height [mm]	L7	21.1 \pm 0.4	21.3 \pm 0.6	18.5 \pm 0.3 ^a
	S1	19.0 \pm 0.5	19.6 \pm 0.7	16.6 \pm 0.3 ^b
spinal canal height [mm]	L7	9.6 \pm 0.2	10.2 \pm 0.4	10.1 \pm 0.3
	S1	7.1 \pm 0.2	7.1 \pm 0.4	7.3 \pm 0.2

^ap< 0.001; different than GSD/NOrDLSS and GSD/rDLSS^bp< 0.01; different than GSD/NOrDLSS and GSD/rDLSS^cp< 0.05; different than GSD/NOrDLSS and GSD/rDLSS

Survey and contrast radiography

The group of GSD/NOrDLSS consisted of 14 dogs without myelographically detected DLSS. Two dogs showed clinical signs of CES (both had painful hyperextension of the tail and one had mild gait abnormalities), but were radiographically normal. In this group, there was also one dog with LTV. Radiographic changes were seen in 5 dogs, none of them showing clinical signs. Spondylosis of lumbar area was found in 4 dogs. Mild sclerosis of the adjacent endplates was found in 4 dogs. The dural sac extended over lumbosacral junction in all GSD/NOrDLSS.

The group of GSD/rDLSS consisted of 10 dogs with radiographic/myelographic signs of lumbosacral stenosis. All of them showed clinical signs of CES; painful lumbar extension was observed in 8 dogs and painful extension of the tail in 5 dogs. Spondylosis of the lumbar area was found in 7 dogs. Sclerosis of the adjacent endplates was found in 8 dogs. The dural sac extended over the lumbosacral junction in 9 dogs. None of GSD/rDLSS dogs had a LTV. Cauda equina compression was greater at lumbosacral spine in extension in comparison to lumbosacral spine in flexion.

The group of MN/NOrDLSS consisted of 12 dogs without myelographically detected lumbosacral stenosis. None of them showed any clinical signs of CES. On the radiographs, none of them had spondylosis, and one of them had a LTV. There

was mild sclerosis of S1 endplate, but not seen on the caudal endplate of L7. The dural sac extended over the lumbosacral junction in 10 dogs. Statistical analysis showed significant association between radiographically confirmed DLSS and the presence of 1) spondylosis (p< 0.05) and 2) sclerosis of S1 endplate (p< 0.05) in GSDs only. The presence of a dural sac extending over the lumbosacral junction, osteophytes of the articular processes, sclerosis of the L7 endplate or LTV were not associated with DLSS in GSDs. No dog in our study had radiographic evidence for SOC.

The incidence of L7/S1 misalignment was the highest in GSD/rDLSS dogs (70%), which also exhibited the largest maximal S1 displacement (GSD/rDLSS = 3 mm, GSD/NOrDLSS = 2 mm, MN/NOrDLSS = 1 mm). In line with this, GSDs had significantly higher L7/S1 misalignment (p< 0.05) and shorter CrS1/SL distance (p< 0.05) than MNs (Table 1). GSDs had significantly higher vertebral bodies (L7; p< 0.001, S1; p< 0.01) but not corresponding spinal canals at L7 and S1 than MNs (Table 1). GSDs were also heavier (p< 0.001) than MNs (Table 1).

Discussion

German Shepherd dogs and Belgian Shepherd dogs (Malinois) are the most common breeds used as working police dogs worldwide. A common cause for the exclusion of police dogs from working

units is CES (11, 12, 13). In our study, some dogs showed difficulty and reluctance to get up and to jump. The dogs seemed to have more problems with extension of the caudal lumbar spine than with flexion. This is probably due to the increase of cauda equina compression that occurs when the caudal lumbar spine is extended.

Dogs that are affected with DLSS may not simultaneously show all clinical signs, but caudal lumbar pain is usually predominant (3, 4, 5). Most often, pain arises as a result of compression of the nerve roots of the cauda equina, although other potential sources of pain include the lumbosacral disc and the articular facets (10). Pain is usually evoked during palpation and hyperextension of the lumbosacral junction, which is highly sensitive, with responses to painful stimuli in 91% to 100% dogs with DLSS (6). In our study 13 GSDs showed pain and 9 (69%) of them were later mielographically confirmed for DLSS.

During clinical examination, exerting pressure over the lumbosacral region, and hyperextension of the caudal lumbar spine and hip joint extension also evoked signs suggesting pain and discomfort in dogs with DLSS. The dogs were radiographed for absence of hip displasia before they were recruited as working dogs, so there is strong evidence that hip dysplasia was not the cause of pain.

DLSS commonly affects medium sized to large breed dogs, at a mean age of six to seven years (20) and occurs more often in male dogs (3, 4, 5). All dogs in our study were large breed dogs. The mean age of affected GSDs was 95.2 months (61 to 117 months). Male-to-female predisposition from 1.7:1 up to 5:1 (3, 5, 7), with a higher mean body weight for male dogs than for female dogs with DLSS, suggests that biomechanical loading plays a role in the pathogenesis (7). In our study, male dogs were overrepresented, so we cannot define male-to-female comparison. Nevertheless, our GSDs had significantly ($p < 0.001$) higher body weight than MNs, which would support the suggestion about biomechanical loading as another predisposing factor for greater incidence of DLSS in GSDs than in MNs. Mainly large breed dogs with a high level of physical activity are predominately affected. The influence of the increased load is supported by the fact that DLSS is extremely rare in small dogs and cats and also in large dogs with less physical activity.

The incidence of the radiologically confirmed DLSS in GSDs in our study was 42 % which is

higher than in previous reports (5, 7, 21). This supports the suggestion of genetic predisposition of GSDs to DLSS (5, 7). The overall incidence of DLSS in our study was 28% which is probably due to presence of only normal MNs.

Diagnostic investigation of CES begins with survey radiographs of the lumbosacral joint, to rule out bone-associated neoplasia, discospondylitis, trauma, and vertebral abnormalities (14). The next indication to take survey radiographs is to identify conditions which may predispose a dog for development of DLSS such as LTV segments and osteochondritis dissecans of the endplate of S1 or L7 (17, 22). Survey radiography (+/- mielography) as a widely available modality still has potential as a screening technique (6).

In our study, survey radiography revealed L7/S1 misalignment in 14 of 36 dogs (13 GSDs and 1 MN), 7 GSDs also had clinical signs. This is considered to be a sign of lumbosacral instability, although the size of the lumbosacral step formation does not always correlate with the clinical signs (3, 6, 7). In our study, lumbosacral step formation was no higher than 3 mm. It was previously reported that lumbosacral step formation is of clinical relevance only when higher than 4 mm (21). In contrast, Suwangkong et al. (2006) suggested that lumbosacral misalignment as low as 2 mm may be clinically relevant.

The height of the body of L7 ($p < 0.001$) and the height of the body of S1 ($p < 0.01$) were significantly greater in GSDs in comparison to MNs. In contrast, there was no significant difference between breeds when comparing the height of the spinal canal at the level of caudal L7 and cranial S1 endplate. These findings support the hypothesis of primary stenosis of the spinal canal in GSDs (1). The L7/S1 spinal canal ratio was less than 2 in all dogs in our study, the highest being 1.7. There were no significant differences between groups nor between breeds. Primary canal stenosis is assumed to be a hereditary disease in large breed dogs and may be a cause of CES (14, 20).

The only anatomical conformation that is correlated with DLSS is a LTV (22, 23). In our study, we diagnosed 2 of 36 dogs (5%) with LTV (1 GSD/NoDLSS and 1 MN/NoDLSS). A LTV is an abnormally formed vertebra between the last normal lumbar vertebra and the first normal sacral vertebra (22). While both symmetrical and asymmetrical LTV may be associated with DLSS, asymmetrical LTV results in a specific pattern of

DLSS consisting of unilateral protrusion of a disk and degeneration of the adjacent bone marrow (24). Lacking ventrodorsal or dorsoventral projection, we could not define whether it was symmetrical or asymmetrical LTV. None of the dogs in our study had SOC, which is in accordance with study of Scharf (25), although SOC was reported in over 30% of predominately male GSDs with CES and 6.4% in clinically normal GSDs (26).

Myelography is a useful diagnostic procedure in the assesment of the stenotic lesions of the spinal canal, but it depends on the extension of the dural sac over the lumbosacral junction. In large dogs the spinal cord ends at L6 and the dural sac extends further caudally (8). Myelography is not diagnostic when the dural sac ends cranial to the lumbosacral junction, when the sac is elevated from the vertebral floor or the compressive lesion is located in the lateral recess or the intervertebral foramen (6). DLSS can be detected when the dural sac extends into the sacrum, which is observed in 80% of dogs with DLSS (17). In our study dural sac extended over LS junction in 33 of 36 (91%) dogs. The diagnostic sensitivity of myelography may be enhanced by using flexion-extension position of the lumbosacral junction (17).

The CrS1/SL distance could play a role in development of DLSS. The greater the distance, there is less possibility of compression during extension. In our study GSDs had significantly ($p < 0.05$) smaller distance and additionally higher lumbosacral step. This could lead to excessive stenosis during the extension of the spine and cause pain even in younger dogs or dogs without radiographically visible degenerative changes.

Advanced imaging procedures, as CT and MRI, are used for more exact evaluation of soft tissues of lumbosacral and foraminal area as well as for the evaluation of the facet joints geometry (6, 16, 27, 28). Due to their accuracy, they are very important in diagnostics as in surgical treatment planning, but so far they remain expensive and frequently not available everywhere. MRI provides excellent soft tissue contrast, so it appears to be superior in detection of spinal stenosis caused by soft tissue proliferation or recognition of early disc degeneration (16, 29, 30, 31). However, there is also lack of correlation between the severity of clinical signs and the severity of compression as determined even by MRI (30).

Regarding to our findings, MNs seem to be more suitable for working dogs. There were only

12 MNs included in this study, but they were approximately of the same age as GSDs (range from 15 to 119 months). Nevertheless, we did not confirm any clinical or radiographical signs of DLSS in this breed.

Slovenian police GSDs and MNs are examined radiographically for hyp dysplasia and elbow dysplasia before accepted into working unit. In addition, radiographic examination of whole lumbosacral spine would be recommended in order to determine LTV, although there was no correlation found in our study.

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RADIOLOŠKA PRIMERJAVA ANATOMSKIH ZNAČILNOSTI LUMBOSAKRALNEGA OBMOČJA MED NEMŠKIMI IN BELGIJSKIMI (MALINOIS) OVČARJI – DELOVNIMI PSI

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Povzetek: Namen raziskave je bili oceniti medpasemske rentgenske razlike in pojavnost kliničnih in rentgenskih znakov degenerativne lumbosakralne stenoze (DLSS) pri 36 aktivnih policijskih delovnih psih; 24 pasme nemški (GSD) in 12 pasme belgijski ovčar (Malinois; MN). Po razgovoru z vodniki psov smo opravili natančen klinični in nevrološki pregled ter rentgensko slikanje lumbalnega in sakralnega dela hrbtenice brez in s kontrastnim sredstvom (mielografija). Svoje delo je brez omejitev opravljalo 33 psov, trije pa omejeno in sicer dva zaradi DLSS in eden zaradi bolezni diska v prsno-ledvenem delu hrbtenice. Šestnajst GSD je imelo znake DLSS, najpogostejši klinični znak je bila bolečina v zadnjem delu hrbta (15 od 16; 94%). Rentgensko smo potrdili DLSS pri 10 GSD (GSD/rDLSS). Potrdili smo razlike v anatomske konformaciji lumbosakralnega dela med pasmama, ki so korelirale s pojavnostjo DLSS pri GSD. Nemški ovčarji so imeli statistično značilno višja telesa sedmega ledvenega vretenca (L7; $p < 0.001$) in prvega segmenta križnice (S1; $p < 0.01$) kot pa MN. Pri GSD je bila stopnica L7/S1 ($p < 0,01$) višja in razdalja CrS1/SL nižja ($p < 0,05$) kot pri MNs. Nemški ovčarji so imeli tudi večjo telesno maso kot MN ($p < 0.001$). Ugotovili smo tudi statistično značilno povezavo med DLSS in spondilozo deformans ($p < 0.05$) ter brstenjem kranialne površine S1 ($p < 0.05$). Pri MN bolezni nismo potrdili, čeprav je bila starost psov obeh pasem med seboj primerljiva. Tudi sicer smo pri MN rentgensko našli manj sprememb na hrbtenici kot pri nemških ovčarjih. Glede na naše ugotovitve, so MN bolj primerni za delovne pse. Omejitev naše študije je majhno število MN, in to, da v študijo ni bil zajet noben MN z DLSS. Med pasmama smo potrdili rentgenske razlike v konformaciji lumbosakralnega predela. Rentgenskega parametra, ki bi lahko bil predispozicijski faktor za razvoj bolezni, nismo odkrili. Za oceno pojavnosti bolezni pri MN bodo potrebne nadaljnje študije.

Ključne besede: lumbosakralni predel; rentgenologija; mielografija; delovni psi; nemški ovčar; belgijski ovčar (Malinois); degenerativna lumbosakralna stenoza