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Research Article

Spinal Infections: Timing of MRI Findings in Dogs

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Abstract

Objective: To assess timing of magnetic resonance imaging (MRI) findings of spontaneous pyogenic spinal infections in dogs.

Method: This retrospective observational study included 61 dogs that underwent MRI for spinal infection (48 cases of diskospondylitis, 10 cases of paravertebral abscess or phlegmon, 3 cases of epidural abscess or phlegmon), confirmed by bacteriology, cytology or histopathology. Data collected included the site of infection, the type of lesion, the degree of neurological dysfunction, the interval between the onset of symptoms and the MRI examination, and the characteristics of vertebral bodies, intervertebral discs, dorsal arthrodial joints, the vertebral canal and paravertebral soft tissues.

Results: The frequency of spinal infections at the different sites differed significantly. The presence and type of vertebral and disk changes associated with diskospondylitis were significantly different according to the time elapsed between the first onset of symptoms and the examination. All patients examined within 5 days from the onset of symptoms showed a reduction in thickness associated with contrast medium uptake of discs involved, as well as vertebral signal hyperintensity on T2-weighted sequences associated with areas of somatic contrast medium enhancement. The magnitude of contrast enhancement was greater in fat-suppressed sequences.

Conclusions: The MRI findings of spontaneous spinal infections are highly distinctive. Changes vary with time and MRI allows early detection, within 5 days from the onset of symptoms. In cases of suspected spinal infection, MRI must be preferred to other diagnostic procedures.

Keywords

Dogs; Spinal Infections; MRI; Vertebrae

Introduction

Infections of the vertebral column are inflammatory conditions of bacterial, fungal or parasitic aetiology of a pyogenic or specific nature [1-4]. The aetiological agents most commonly isolated in dogs and humans are *Staphylococcus aureus and S. intermedius* [3,5-8]. Other commonly isolated microorganisms include *Streptococcus* spp., *Brucella canis* and *Escherichia coli*. Less commonly isolated microorganisms are *Actinomyces* spp., *Bacteroides* spp., *Coccidioides immitis*, *Corynebacterium* spp., *Mycobacterium* spp., *Nocardia* spp., *Paecilomyces* spp., *Pasteurella* spp. and *Proteus* spp. Infections

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attributed to Aspergillus spp., Enterococcus faecalis, Fusarium spp., Mucor spp., Paecilomyces variotii, Pseudomonas aeruginosa, Staphylococcus epidermidis, Bordetella spp, Blastomyces dermatitidis and Candida albicans have also been reported [6-33].

Spinal infections that cause destructive and proliferative structural changes in the vertebral bone, characterised by destructive and proliferative changes in the vertebrae, are defined as osteomyelitis or spondylitis [9]. Immature animals can display a particular form of vertebral infection called physitis, whereby the septic process involves the vertebral metaphyseal-epiphyseal region [25]. Diskospondylitis and spondylodiscitis represent particular forms of vertebral osteomyelitis in which the phlogistic process involves the intervertebral disc, the vertebral end plates and the contiguous vertebral bodies [5-9,18-21]. In dogs, discitis is not recognised as a distinct nosologic entity [7,20]. The existence of pure discitis is currently under discussion in veterinary and human medicine after the presence of spondylodiscitis was confirmed in all radiological diagnoses of discitis in recent magnetic resonance imaging (MRI) studies [1]. Pyogenic arthropathy of articular facets is instead a distinct nosologic entity [1,2]. Diffusion of the process towards the neural canal causes epiduritis, epidural abscess or phlegmon [18]. Epidural and paravertebral abscesses and phlegmon can be caused by spinal infection; however, they can also develop independent of spondylodiscitis and be defined as primary [1]. The spread of the phlogistic process to endocanalicular structures may cause myelitis, ganglioradiculitis and phlebitis of the venous plexus [27].

Regarding diskospondylitis, radiographic examination can reveal the first signs of bone involvement after 2 to 8 weeks, but this is difficult to distinguish from arthritic degeneration during the early stages [18]. Although 99mTc or Ga67 bone scintigraphy allows the inflammatory process to be recognised earlier than traditional radiology, it has a low specificity and sensitivity, as well as some limitations concerning the anatomical resolution. Computed tomography (CT) can detect bone and disc changes later than scintigraphy, although it is better for monitoring the spread of the infection to the paravertebral soft tissues and toward the epidural space [18].

In human medicine, MRI is considered the gold standard in diagnostic examination for spinal infections due to its higher sensitivity and specificity than scintigraphy, mainly during the early stages of the disease [18,29].

With the exception of an experimental study by Szypryt et al. in 1988 on diskospondylitis in rabbits, papers regarding the timing of MRI findings of spinal infections are lacking. In particular, no study has been carried out to assess the MRI findings of spinal infections during the history of the disease (natural or during antibiotic therapy) nor the sensitivity and specificity of this method has been assessed. The aim of the present retrospective study was to evaluate the timing of MRI findings of spontaneous pyogenic spinal infections in dogs.

Materials and Methods

Inclusion criteria

The medical records of dogs registered in the internal database of our referral center from January 2010 to June 2015 were reviewed.

Inclusion criteria were a diagnosis of spinal infection (vertebral osteomyelitis, diskospondylitis, vertebral septic arthrosynovitis, paravertebral phlegmon or abscess, epidural phlegmon or abscess) diagnosed through MRI and confirmed by bacteriology, cytology or histopathology. Paravertebral and epidural abscesses and phlegmons were divided into diskospondylitic (i.e., associated with diskospondylitis) and non-diskospondylitic (patients that did not display any diskospondylitis during examination).

Procedure

The parameters evaluated were: the site involved; the type of lesion; the degree of neurological dysfunction (0, normal; 1, only pain; 2, ambulatory palsy; 3, non-ambulatory palsy; 4, paralysis with deeppain perception; 5, paralysis without deep-pain perception); the elapsed time between the first onset of symptoms recongized by owners and MRI examination; the characteristics of the vertebral bodies (the presence of erosion of end plates and the signal of bodies under basal conditions and after intravenous contrast medium injection); and the characteristics of intervertebral discs (thickness and signal), the vertebral canal and paravertebral soft tissues. Following the neurological and anaesthesiological examination, each patient was sedated with acepromazine (5-15 mcg/kg), tramadol (1-2 mg/kg) or fentanyl (1-5 mcg/kg). After induction with diazepam (0.1 mg/kg) and propofol (1-3 mg/kg), all patients were subjected to orotracheal intubation and kept under inhalation anaesthesia with spontaneous or assisted ventilation with isoflurane in oxygen and continuous administration of fentanyl.

The analysis was carried out in the dorsal decubitus position using a 1.5 T superconductive whole-body MRI scanner and QD spine coil developed at our centre. The study of the body regions involved scan acquisition oriented in the sagittal, dorsal and transverse planes on SE T2-weighted sequence with spectral fat suppression (TR 3000, TE 120, NEX 2, matrix 256 \times 194) and FE T2*-weighted (TR 500, TE 22, FA 25, NEX 2, matrix 256 × 194), SE T1-weighted (TR 500, TE 20, NEX 2, matrix 256×256) with fat signal suppression, and FE T1-weighted (TR 320, TE 14, NEX 2, matrix 256 × 256) under basal condition and after injection of intravenous contrast medium (gadodiamide 0.5 mmol/ml at the dose of 0.2 ml/kg), with a FOV varying from 10 to 35 cm. Assessment of the extent of contrast medium enhancement was carried out both on a subjective basis (operator's observation) and on an objective basis (using the dedicated comparison program of the MRI scanner). All patients were subjected to at least one MRI examination and, if possible and/or necessary, to further control MRI examinations. Bacteriological and cytological analyses were carried out on material collected surgically or by fluoroscopyor CT-guided techniques, and histopathological analyses were performed on material collected during surgery. Patients who did not show recurring symptoms 12 months after treatment were considered to have recovered.

The frequency distribution from the onset of symptoms and MRI findings were analysed using the chi-squared test on a double entry Chart. The significance level of the test was fixed at p = 0.05.

Results

A total of 5881 neurological clinical cases were considered, 61 of which met the inclusion criteria.

Signalment

The 61 dogs (32 males and 29 females) were aged between 8

months and 15 years (aged 7 years on average, standard deviation of 2.1 years; Chart 1). Nine were medium to small dogs, and 52 were big or giant size. There were 16 German shepherds, six Labradors, six Rottweilers, four Boxers, three Beagles, three Dobermanns, three Setters, three Crosses, two Bloodhounds, two Scent hounds, one Great Dane, one Poodle, one Sennenhunde, one Bulldog, one Breton, one Corso, one Pug, one Maltese, one Belgian Shepherd, one Maremma sheepdog, one Pointer, one West Highland White Terrier and one Yorkshire Terrier.

Type of disease

Of the 61 patients, 48 (77%) were diagnosed with diskospondylitis, 10 (16%) with non-diskospondylitis paravertebral abscess or phlegmon, and 3 (7%) with non-diskospondylitis epidural abscess or phlegmon.

Site

The site of diskospondylitis was singular in 36 cases (74%) and multiple in 12 cases (26%), with a total of 65 discs involved (Chart 2). Non-diskospondylitic paravertebral phlegmons or abscesses were located in the cervical region in two cases, in the thoracic region in two cases, in the lumbar region in four cases and in the lumbosacral region in two cases. Non-diskospondylitic epidural phlegmons and abscesses were located in the thoraco-lumbar region in three cases and in the lumbosacral region in one case.

Neurological grade

Of the 10 patients affected by paravertebral abscess or phlegmon, one was grade 0, six were grade 1, two were grade 2 and one was grade 3. Of the three patients affected with epidural abscess or phlegmon, there were one in each of grade 2, grade 3 and grade 4. The 48 diskospondylitic patients included 13 (26%) grade 1, 23 (48%) grade 2, six (13%) grade 3 and six (13%) grade 4.

Duration of symptoms

The time span between the onset of symptoms and the first MRI examination ranged between 2 and 120 days (Charts 3 and 4).

Changes in the vertebral bodies

Erosions: None of the patients affected by non-diskospondylitic paravertebral or epidural abscesses or phlegmon displayed erosion of the vertebral end plates. Of the 65 sites of diskospondylitis, 14 had no signs of erosion at the first examination (Figures. 1 and 2). Among the group of 22 patients examined within 5 days from the onset of symptoms (seven cases, 11 discs), four (18%) showed erosions, while 32/42 (76%) of the group examined within 6 to 10 days (14 cases, 21 discs) showed erosions. Erosion involving the vertebral end plates was observed in 25/26 patients (31/32 discs, 97%) examined more than 10 days after the onset of symptoms. In all cases, the erosion involved both disc end plates. In one 8-month-old patient examined 20 days after the onset of the first symptoms with L3-L4 involvement, the extent of erosion of the caudal end plate of the cranial vertebra was decidedly prevalent, in line with the extension of what was originally physitis (Figure 1).

Signal of vertebral bodies: None of the patients affected with non-diskospondylitis paravertebral or epidural abscesses or phlegmon showed variation in the signal of vertebral bodies in the sequences under basal conditions and after intravenous contrast medium injection. Of the 65 diskospondylitis sites assesses by T1-weighted Citation: Dolera M, Malfassi L, Sala M, Marcarini S, Mazza G, et al. (2018) Spinal Infections: Timing of MRI Findings in Dogs. J Vet Sci Med Diagn 7:1.

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sequence under basal conditions, 22 (34%) showed isointense signals of a variable portion of the involved vertebrae, five (8%) showed hyperintensity and the 38 (58%) remaining sites showed regions of hypointensity compared to the values of a normal vertebral body. In the T1-weighted sequence, isointensity of the vertebral bodies involved was present in 6/7 cases (86%) in the group of patients examined within 5 days of symptom onset, 4/14 (29%) in the group examined on day 6 to 10, 3/6 (50%) in the group examined on day 11 to 15, 2/7 (29%) in the group examined on the day 16 to 20, and in 2/13 of those examined after more than 21 days (15%). Only 2/48 (4%) showed no hyperintense regions in the vertebral bodies involved on SE T2-weighted and FE T2*-weighted sequences, one in the group



Chart 4: Synoptic tables of the frequency of the changes detectable with MR of the discs and of vertebrae of patients affected with diskospondylitis. vT1: signal of vertebral bodies on T1-weighted sequence, vT2: signal of vertebral bodies on T2-weighted sequence, vG: signal of vertebral bodies on T1-weighted sequence, dT2: signal of the intervertebral disc on T1-weighted sequence, dT2: signal of the intervertebral disc on T1-weighted sequence, dG: signal of the intervertebral disc on T1-weighted sequence, dG: signal of the intervertebral disc on T1-weighted sequence, dG: signal of the intervertebral disc on T1-weighted sequence, dG: signal of the intervertebral disc on T1-weighted sequence, dG: signal of the intervertebral disc on T1-weighted sequence, dG: signal of the intervertebral disc on T1-weighted sequence, dG: signal of the intervertebral disc on T1-weighted sequence, dG: signal of the intervertebral disc on T1-weighted sequence, dG: signal of the intervertebral disc on T1-weighted sequence, dG: signal of the intervertebral disc on T1-weighted sequence, dG: signal of the intervertebral disc on T1-weighted sequence, dG: signal of the intervertebral disc on T1-weighted sequence, dG: signal of the intervertebral disc on T1-weighted sequence after intravenous contrast medium injection.

Figure 1: Male Rottweiler dog 8 months old, caudal physitis in L3 progressed to diskospondylitis in L3-L4.

examined between day 16 and 20 and one in the group examined after 21 days. After intravenous contrast medium injection, only 1/48 (2%) showed no enhanced regions of the bodies involved (Figure 2) on the T1-weighted sequence. The subjective contrast medium enhancement in 25/65 sites (39%) revealed easier assessment of scans taken using the fat-suppression method, while in the objective assessment enhancement was higher in all scans carried out by the fat-suppression method. The quantitative objective assessment revealed greater enhancement in all scans taken in the dorsal plane compared to those carried out in the sagittal plane.

Disc changes

Thickness: All sites of diskospondylitis showed a reduction in the thickness of the intervertebral disc involved. None of the patients affected with paravertebral or epidural abscesses or phlegmon showed a reduction in the thickness of the discs affected by the pathological process.

Signal: Of the 65 diskospondylitis discs, 58 (90%) showed signal hypointensity on the T1-weighted sequence under basal conditions when compared to nearby discs. Three out of the six isointense discs belonged to patients examined between the 2nd and 5th day from the onset of symptoms (3/11, 27%) and the remaining three were those examined 6 to 10 days later (3/21, 14%). Fifty out of 65 discs (78%) showed hyperintense signals in the T2-weighted sequence. Of the 14 signals that were isointense relative to the nearby discs, six belonged to patients examined within 5 days of symptom onset (6/11, 54%), three examined between the 6th and the 10th day (3/21 14%) and five between the 21st and the 30th day (5/16, 31%). None of the patients affected by paravertebral or epidural abscesses or phlegmon showed a reduction in the signal of the discs affected by the pathological process in the sequence. After intravenous contrast medium injection, all diskospondylitis discs showed enhancement. Of these, 41 showed nodular enhancement and 23 showed peripheral enhancement.

Changes in the vertebral canal: Ten of the 48 (21%) patients affected by diskospondylitis did not show any changes in the vertebral canal. Among the remaining 37 cases with involvement of the vertebral canal, 23 (62%) showed disc protrusion with annular enhancement following intravenous contrast medium injection, seven (19%) had epidural phlegmon, four (11%) had an epidural abscess, one (3%) showed interarcual ligament hypertrophy, one (3%) had myelitis and the remaining one patient had (3%) basivertebral phlebitis. Changes in the vertebral canal were observed in 9/12 (75%) patients with grade 3 and 5/6 (83%) patients with grade 4 neurological dysfunction. Of the

Figure 2: Male pointer 9 months old; MRI of the cervical spine on FE T1weighted sequence after intravenous contrast medium injection, medial sagittal plane, chronic diskospondylitis in C6-C7-T1 in association with vertebral anchylosis and interarcual ligament hypertrophy in C5-C6.

examined using MRI 5 days after the onset of symptoms, top-down sagittal scans, with FE T1-weighted sequence under basal conditions (Figure a), SE T2-weighted with fat signal suppression (Figure b), SE T1-weighted with fat signal suppression after intravenous contrast medium injection (Figure c). Please note the reduction in thickness of the dorsal portion of the disc involved, vertebral hypointensity on T1-weighted sequence under basal conditions, disc and vertebral hyperintensity on T2-weighted sequence, epidural and paravertebral phlegmons, the enhancement of intravenous contrast medium into the disc, vertebrae and in paravertebral and epidural inflamed tissues.

10 patients affected by paravertebral phlegmon or abscess, one case (10%) showed epiduritis and two cases (20%) had epidural phlegmon.

Dorsal septic arthrosynovitis: Two patients affected by diskospondylitis of the L7-S1 intervertebral disc (4%) simultaneously showed unifocal dorsal septic arthrosynovitis of L5-L6 in one case and L3-L4 in the other.

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Changes in the paravertebral region: Of the 48 patients affected by discospondylitis, 32 (68%) showed paravertebral phlegmon and 10 (21%) osteophytosis. Two patients (4%) had costochondral osteomyelitis.

MRI follow-up

Thirteen dogs were subjected to MRI follow-up checks over time. Two patients who failed to respond adequately to the antibiotic treatment were reassessed 15 days after the first MRI examination (20 and 40 days from the onset of symptoms). One showed a paravertebral phlegmon which was absent at the first examination; therefore, it was decided to perform drainage and surgical omentalisation. The other patient (Figures 3-5) showed erosion of the end plates, which was absent during the first examination. The latter carried on the antibiotic treatment for a further 3 months, and achieved complete symptom remission. A third MRI examination of this patient revealed a reduction in disc enhancement and an increase in vertebral osteophytosis. Another patient that showed apparent clinical success in response to medical treatment during two follow-up MRI evaluations carried out 3 and 6 months after the first examination revealed an increase in vertebral lysis. Considering the overall good health of the patient, the owners did not allow any further checks, and after discontinuation of the treatment the patient had remained symptomless for 9 months, which was when this article was prepared. The remaining 10 cases subjected to a routine checkup 2 months after the first examination showed a reduction in signal hyperintensity on T2-weighted sequences involving the vertebral bodies and the disc involved, as well as a reduction in the extent

with antibiotic therapy without appreciable results; right image (Figure d,e,f), examination carried out after a further 3 months following modification of therapy giving good clinical results. After 15 days of ineffective therapy, erosions of end plates appeared and phlogosis extended. After 3 months of suiChart therapy, a reduction in phlogosis and the onset of osteophytosis could be observed; yet a dorsal arthrosynovitis in L3-L4 was quite evident.

Figure 5: Left image (Figure 5a), female cross 2 years old; MRI of the thorax on FE T1-weighted sequence after intravenous contrast medium injection, axial plane, cervico-thoracic paravertebral abscess associated with retrosternal lymphadenopathy; centre image (Figure 5b); male Doberman 8 months old; lumbosacral MRI m 8 on FE T2*-weighted fat suppression sequence, axial plane, lumbosacral primary epidural abscess; right image (Figure 5c), male German Shepherd dog 10 years old; lumbar MRI on FE T2*-weighted sequence, axial plane, diskospondylitis secondary paravertebral phlegmon.

and/or extension of contrast medium enhancement. However, the perivertebral phlegmon had been replaced by osteophytosis in these cases.

Statistical analysis

The chi-squared test revealed a significant difference in the distribution of frequencies (p < 0.001), thus indicating a non-casual distribution between the onset of symptoms and the MRI findings.

Discussion

The exact incidence of spinal infections in veterinary medicine is unknown. A study performed by Burkert et al. [7] in 2005 reported a diskospondylitis prevalence of 0.09-0.77% in American veterinary hospitals (general case records) between 1980 and 2001 [7]. In our neurological specialist case records, the prevalence was found to be 1.03% for spinal infections and 0.799% for diskospondylitis. There may be a higher prevalence in America than in Italy; however, the prevalence distribution related to the spinal location are comparable. Although all ages are represented in our case records, older animals were affected more often. While diskospondylitis was prevalent among the spinal infections observed in the current study, paravertebral and epidural phlogosis must not be underestimated during diagnostics. Physitis (one case) was confirmed to be rare. In particular, as indicated by the present case records, epidural sepsis was always a clinical emergency, with all patients examined coming to us within 5 days from the onset of symptoms. The MRI findings of epidural phlegmons and abscesses observed in the study are comparable to those mentioned in a recent article that reported five cases with this lesion [30], and are in accordance with findings described in the human medical literature [31,32].

For the first time, this study described the evolution of MRI findings of diskospondylitis at different times, and demonstrated that not all detecChart changes develop at the same speed. The earliest (present in all patients examined between the day 3 and 15) and most consistent MRI signs of diskospondylitis were the reduction in thickness of the disc involved, the vertebral somatic hyperintensity on T2- and T2*-weighted sequences and the disc and vertebrae contrast enhancement. Signal hypointensity on the T1-weighted sequence under basal conditions and signal hyperintensity on the T2-weighted sequence of the disc involved were less consistent in the early stages, but were present in all patients after at least 10 days from symptom onset. Erosion of end plates is rarer in the early stages (18% of cases within 5 days), yet equally recognisable after at least 10 days. Despite its increased presence indicating disease progression, the most inconsistent finding was the vertebral signal hypointensity on the T1-weighted sequence under basal conditions. After more than 15 days, a slight decrease in the percentage of signal hyperintensity on T2-weighted sequences in the discs and the vertebrae was observed, as well as a slight reduction in the percentage of cases that showed regions of vertebral somatic enhancement. As assessment of the disc and somatic enhancement was found to be easier when carried out on scans taken using the fat-suppression method and acquired in the dorsal plane, this data should be considered in dubious cases. Although these findings cannot be easily compared in the temporal point of view, they can be compared to those described in human medicine [18,29,32]. Understanding the MRI semiotics of infective lesions of the spine is strictly dependent on the type of lesion [33]. Concerning changes involving the vertebral bodies, signal hyperintensity on the T2-weighted sequence is related to inflammatory oedema in the cancellous bone, and the loss of signal found in some patients during the most advanced phase can be due to hemosiderin deposits or osteoblastic reactions. The characteristics of the vertebral signal on T1-weighted sequences in the acute phase are correlated with oedema and with early demineralisation, whereas during chronicisation, any hyperintensity under basal conditions may be caused by macrophage infiltration or by adipose substitution. Hyper-uptake of intravenous contrast medium can be caused by local vasodilatation and vasopermeabilisation that, with the passing of time, can decline at some points due to infarctions and analogous involutionary phenomena or bone densification. According to some authors, the reduction in disc thickness can be attributed to the partial annulus and/or nucleus pulpous disruption while the hyperuptake of the disc reveals massive development of neoformed disc vessels. Nodular enhancement of the disc suggests the presence of phlegmon, whereas peripheral enhancement is indicative of a disc abscess. Moreover, disc hyperintensity on the T2-weighted sequence is connected to an increase in existing free water, while the possible loss of signal in the most advanced cases may be caused by either hemosiderin deposits or fibrosis [33].

The analysis of pathogenic hypotheses of diskospondylitis should also be discussed. Spinal infections may be spontaneous (haematogenous diffusion or proximity of septic focus, puncture injuries, migration of foreign bodies) or iatrogenic [2,3,5,20,22-24,33]. The pathogenesis of diskospondylitis remains controversial, and differences are assumed depending on the age of the patients. The vascularisation of the annulus during childhood increases the chance of infection onset at the level of the intervertebral disc, whereas in adults it would primarily take place in the medullary cavities of the cancellous bone of vertebral bodies. Therefore, in adults, involvement of the end plate and disc with further extension of the phlogistic process to the paravertebral structures and the epidural space would only take place later on [23]. Nevertheless, although the intervertebral disc is generally considered to lose vascularisation with skeletal maturity, extensive anatomical studies on human patients have cast doubt on this theory. Disc vascularisation is progressively reduced with age, causing a sharp reduction in the number of afferent vessels of the nucleus pulposus from the contiguous vertebral plates, although anastomotic circumferential vascularisation to the relevant vertebrae is maintained in the periphery. However, the number of neoformed vessels is still greater in degenerated discs. This would sustain the aetiopathogenesis of primary haematogenous pyogenic diskospondylitis with early involvement of the intervertebral disc in adults [9]. Haematogenous vertebral osteomyelitis is considered rare in adult animals, as the closure of epiphyseal cartilage growth determines the disappearance of the vascular barrier of the epiphysealmetaphyseal region [6,26]. On the contrary, haematogenous vertebral osteomyelitis would be a typical pathology of animals younger than 2 years old. In young animals, the capillary network extending from the metaphysis of growing bones to the physis shows a discontinuous epithelial covering and slow blood flow [6,25]. Moreover, capillary vascular buds invading terminal hypertrophic chondrocytes (primary spongiosa) lack a basement membrane and show discontinuity in their endothelium [6,26]. In addition, the substantial deficiency of leukocytes in the primary spongiosa makes it particularly prone to infections [6].

In our case records, all patients affected with diskospondylitis that were examined at an early stage revealed both disc and vertebral lesions independent of age. It is worth noting that the only patient affected by physitis that progressed to diskospondylitis was of

paediatric age. However, as the number of patients of paediatric age involved in this study was limited, it would be desirable to carry out further studies.

During diskospondylitis or paravertebral sepsis, the extension of the phlogistic process to the endocanalicular structures may underlie the disappearance of neurological symptoms [27]. However, in our patients, the extension of the process to the vertebral canal was not associated with a higher degree of neurological dysfunction, as 75% of patients in grades 1 and 2 showed endocanalicular lesions. Nevertheless, one patient in grade 4 showed no visible medullary or epidural lesions. The presence of signs of deficiency may, in fact, depend on vasculitic or neural vasospasm phenomena rather than direct involvement of the nervous structures by the infectious process [8].

Inflammation of paravertebral tissues is a frequent finding during spinal infection, and its presence is of great assistance when making the diagnosis. Over 90% of human patients affected by diskospondylitis showed evidence of inflammation in the paravertebral tissues and involvement of the epidural space [24]. Although our case records indicate that paravertebral phlegmon is quite frequent, it was observed in 68% of diskospondylitis cases, and therefore, cannot be considered a discriminating diagnostic finding. It is interesting that two cases of diskospondylitis also had osteomyelitis of costochondral junctions. Although known to the Authors, it has never been described in veterinary medicine, despite having been reported to be a rare occurrence in human medicine [29,33].

Based on data obtained during the present study, the relevance of MRI in the diagnosis of spontaneous spinal infections in dogs can be asserted. The diagnostic possibilities of MRI in the study of spinal infections are related to the high resolution of the contrast medium, multiple planes, the ability to directly visualise the bone marrow and neural structures, and the high sensitivity of the analysis to variations in aqueous content. The greatest advantages of MRI are the very high sensitivity and specificity and early diagnosis. These elements allow MRI to have remarkable potentiality in the early diagnosis of this pathology, both the acute forms and reacutisation of chronic forms, as well as in the identification of complications, in the assessment of extension of the process and in the identification of pathological regression when compared to the other imaging methods.

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