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Case Report
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A Rare Case of *Salmonella* Spp. Osteomyelitis in a Dog

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Introduction

Osteomyelitis is an inflammatory condition of bone usually caused by infectious agents such as bacteria, fungi or viruses. The disease is characterized by systemic illness, pain and soft tissue swelling with visible radiographic alterations in bone. The most common bacteria isolated in cases of osteomyelitis in dogs and cats are *Staphylococcus* spp. (60% of cases), followed by *Escherichia coli* and *Streptococcus* spp. [1,2]. To our knowledge, this is the first canine case of *Salmonella* spp. osteomyelitis.

Case Presentation

A 7 months old, male mixed breed dog weighing 16.5 kg was presented to XXX for worsening lameness on the right hind limb from 3 weeks. No other clinical sign was present. The dog was adopted from Sicily 4 weeks earlier, regularly vaccinated but without prophylaxis for ectoparasites. Other anamnestic information was unknown.

On presentation, the physical examination revealed poor body condition (BCS of 3/9), muscular hypotrophy of the right hind limb and increased thickness of the right femur with algia to palpation. The dog also had generalized lymphadenomegaly. Blood tests and hind limb radiography were performed. Hematologic abnormalities at presentation included normocytic, normochromic, mild regenerative anemia (Hematocrit [Hct] 32.2%), leukopenia (2.84×10^3/mL; reference range, 6-17 × 10^3/mL) characterized by lymphopenia (0.8×10^3/mL; range 1-4.8 × 10^3/mL), neutropenia 1.69 × 10^3/mL (range 3–12 × 10^3/mL) and thrombocytopenia (8×10^3/mL; reference range 160-500 × 10^3/mL). The blood chemistry panel, including electrolytes, was normal except for hypoalbuminemia (2.02 g/dL; reference range 2.75 g/dL to 3.85 g/dL) and a decreased albumin/globulin ratio (0.46; reference range 0.75-1.35). Electrophoresis showed hypergammaglobulinemia. Coagulation panel was in the range of normality. Indirect Immunofluorescent (IF) assay test was performed on suspicion of an infectious disease, with positivity for *Ehrlichia canis* with a title of 1:1280. The radiographic exam of the right hind limb (Figure 1) revealed a focal osteopathy with severe mixed proliferative-lytic pattern. In particular, it was evident a focal deformation of the distal third of the femoral diaphysis, characterized by a severe and non-homogeneous increase of the radiopacity of the bone with evidence of a radiolucent, sharply round, intralesional area. Moreover, there were an extensive proliferation of periosteal bone tissue with "a palisade" aspect, in correspondence with the caudal aspect of the lesion and thickening of the cortical bone involving a large part of the femoral diaphysis. The main differential diagnoses for this type of bone lesion were osteomyelitis or bone abscess with sequestrum (of bacterial or fungal origin) or neoplasia. Therefore, it was decided to carry out a bone biopsy and X-rays of the chest to exclude metastatic involvement. The lesion bone biopsy was performed with the patient under general anesthesia with a Jamshidi needle 10G: Seven bone biopsies were performed, of which four underwent histological examination; two were subjected to bacteriological examination and one to PCR examination for *Ehrlichia canis* detection. Waiting for the results of biopsy, the patient was placed on doxycycline 7.5 mg/kg BID for the treatment of *Ehrlichia canis*.

The histological examination revealed a moderate, chronic lympho plasma cellular osteomyelitis with areas of necrosis, severe fibrosis and bone remodeling. The PCR was negative for the presence of *Ehrlichia canis*, while the bacteriological culture was positive for the presence of *Salmonella* spp. with isolation of large amounts of the bacteria. A stool test was also performed which was negative for parasitic elements and negative for the presence of Salmonella spp. According to the antibiogram, *Salmonella* spp. was sensitive to doxycycline, therefore the already set therapy was kept unchanged. Clinical and radiographic checks were performed once a month for the first three months, then every 3 months up to a year. One month after the start of therapy, the dog was no longer limping. Check blood tests was performed with the resolution of hematological abnormalities. After 6 weeks an additional bone biopsy was performed to evaluate the effectiveness of the therapy. Bacteriological

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Figure 1: Orthogonal radiographic projections (medio-lateral and cranio-caudal views) of the bone lesion at the time of diagnosis, showing a mixed proliferative-lytic lesion. The distal third of the femoral diaphysis is severely thickened and characterized by severe and non-homogeneous increase of the radiopacity of the bone with evidence of an intralesional, radiolucent, sharply round area. An extensive "palisading" periosteal reaction and thickening of the cortical bone are also present. Surrounding soft tissues are thickened and increased in radiopacity.

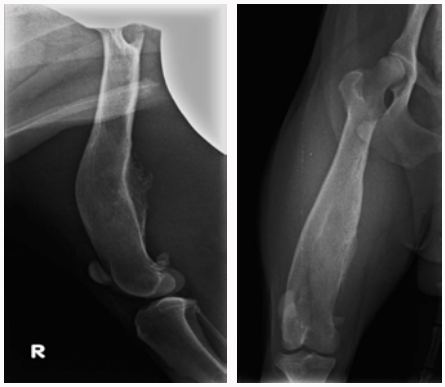

Figure 2: Orthogonal radiographic projections (medio-lateral and cranio-caudal views) of the bone lesion after nine months. The lytic lesion is no longer evident while the "palisading" proliferative reaction is significantly reduced. Focal deviation and thickening of the distal third of the femoral diaphysis persist.

examination of biopsies was negative. The focal lytic lesion of the bone progressively disappeared, and the periosteal reaction was considerably reduced while maintaining a thickening of the cortical bone (Figure 2). Doxycycline therapy was stopped after negative bacteriological result of bone biopsies.

Discussion

Osteomyelitis is an inflammatory condition of bone usually caused by infectious agents, such as bacteria, fungal or viral agents [1-3]. The condition generally results from iatrogenic or spontaneous inoculation of these agents into traumatic or surgical wounds [2,4]. It can also develops following hematogenous spread to the bone, and occurs relatively more frequently in young than in adult animals, especially in those with predisposing conditions including failure of passive transfer of maternal immunity or concurrent infection [5]. Hematogenous osteomyelitis most frequently involve the metaphysis and epiphysis of developing bones in young dogs, and the diaphysis of long bones in adults, and localization within vertebral bodies can also occur [6,7]. Radiographic evaluation is often helpful in successfully diagnosis of osteomyelitis, but the current gold standard is a positive microbial culture. The most common bacteria isolated in cases of osteomyelitis in dogs and cats are *Staphylococcus* spp. (circa 60% of cases), followed by *Escherichia coli* and *Streptococcus* spp. Other Gram-negative organisms (e.g., *Pasteurella*, *Pseudomonas*, *Proteus*, *Serratia* and *Klebsiella* species) and Gram-positive organisms (e.g., *Corynebacterium* spp., Enterococci) have also been isolated. Anaerobic organisms should also be taken in consideration (e.g., *Bacteroides*, *Nocardia*, *Clostridium*, *Actinomyces*, *Fusobacterium*), and polymicrobial infections are not uncommon. Moreover, fungal agents (e.g., *Blastomyces*, *Aspergillus*, *Candida*, *Cocidioides*, *Cryptococcus*, *Histoplasma*) have been also isolated, even if not so commonly, and so are viral agents [8,9]. *Salmonella* is a very rare agent of osteomyelitis and there are only few cases reported in human medicine [10]. Even if young animals are thought to be predisposed to hematogenous osteomyelitis, in this case we present, the first suspect was a post traumatic osteomyelitis (bite injury or penetrating wound) due to the localization of the lesion and the severe periosteal reaction, usually not present in hematogenous infection [3]. However, being the patient's remote medical history unknown and blood culture not performed, a hematogenous infection cannot be totally excluded. Osteomyelitis can generally be managed medically, but some cases require surgical debridement with removal of sequestrum and necrotic bone or surrounding necrotic soft tissues [6,7,11,12]. Antibiotic treatment should be based on an antimicrobial susceptibility test whenever possible. However, until culture and antibiotic susceptibility test results are available, broad-spectrum antibiotics should be administered [13]. The prognosis of osteomyelitis depends on the time of the presentation, the degree of alteration in bone architecture and response to treatment [14]. In the case shown the choice of antimicrobial therapy was based on the outcome of the antibiogram and doxycycline was chosen as a treatment also for *Ehrlichia canis*.

Conclusion

This case represents a rare and unique presentation of *Salmonella* osteomyelitis in a dog. Osteomyelitis remains a challenge in all animal species commonly encountered in veterinary medicine. A positive culture and the corresponding antibiotic susceptibility test are helpful for an effective treatment. Some new antimicrobial approaches are emerging from basic sciences and human medicine, but these are only slowly emerging in veterinary medicine.

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