Post-Traumatic Osteomyelitis in Dogs and Cats and the Comparison with the Incidence of Bacterial Colonisation in Removed Plate Implants

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ABSTRACT

Objective: To evaluate the incidence of post-traumatic osteomyelitis in 65 animals (dog n=51; cat n=14) and compare this with the incidence of bacterial colonisation of the removed plate implants in the same study group.

Study Design: retrospective study

Sample Collection: Data were further collected from the medical records of the animals presented between February 2010 and March 2013 for the removal of plate implants and included sex, age, weight, antibiotic therapy, clinical, and radiological presence of osteomyelitis.

Methods: Presence of clinical signs and radiographic changes typical for osteomyelitis, pus on aspiration, and positive bacterial culture, were evaluated. The animals were considered as patients with osteomyelitis if two or more of these criteria were present. Incidence of the osteomyelitis in the study group was then statistically compared with the findings published by Pagel (2015)[1] on the incidence of bacterial colonisation of the removed plate implants in the same animal group.

Results: Five dogs (5/51; 9,8%) and no cats (0/14; 0%) showed osteomyelitis. Mean age and mean weight were 6,6 ± 4,7 years and 35,2 ± 12,6 kg, respectively. The most common clinical signs were localised swelling (5/5), local pain (5/5) and lameness (5/5); in radiological signs soft tissue swelling (5/5) and osteolysis (5/5). Bacterial culture yielded St pseudintermedius in all cases. Compared to the previous study by Pagel (2015), the incidence of bacterial colonisation (n=33; 50,8%) was significantly higher ($P<0,01$) compared to the incidence of osteomyelitis (n=5; 7,8%).

Conclusions: This study shows that the incidence of bacterial colonisation was signifi-

cantly higher than the incidence of osteomyelitis. Although the majority of animals were clinically healthy, bacteria were nevertheless present on the implants. Based on these findings a timely explantation of plate implants is recommended.

INTRODUCTION

Osteomyelitis, an inflammatory condition of the bone, is usually considered to be an infectious process caused by an infectious agent.[2] Osteomyelitis initiated by direct inoculation (post-traumatic) is the most common bone infection seen in companion animal practice.[3] Bone infection involves a deleterious interaction between the host and the offending causative agent. Bacteria must not only contaminate, but also colonise the bone and surrounding tissues to cause an infection.[4] To the authors' knowledge, a study comparing the incidence of osteomyelitis with the incidence of bacterial colonisation in removed plate implants has not yet been published in the field of veterinary medicine.

MATERIALS AND METHODS

Selection of Cases and Collection of Data

All patients were presented at the Small animal clinic of the Freie Universität Berlin between February 2010 and March 2013 for the removal of plate implants. These plates were priorily used for fracture repair or for arthrodeses in the same clinic. The animals were excluded if they did not have a complete medical history and radiological examination at the time of explantation. Data were further collected from the medical records of the animals in the study group and included species, breed, weight, age, sex, antibiotic therapy, clinical, and radiological presence of osteomyelitis.

Diagnostic Criteria for Osteomyelitis

Two or more of the listed findings must be present for establishment of the diagnosis:[5]

1. Presence of clinical signs and symptoms of osteomyelitis
2. Radiographic changes typical for osteomyelitis
3. Pus on aspiration
4. Positive bacterial culture

Clinical Signs

Data of the clinical examination at the time of explantation were evaluated for a presence of the following clinical signs:

- inappetence
- lethargy
- fever
- localised swelling
- pain, and
- lameness

of the affected limb.[6]

X-ray Analysis

Plain radiographs performed at the time of explantation were evaluated for a presence of the following radiological findings:

- soft tissue swelling
- periosteal thickening
- lytic lesions
- endosteal scalloping
- osteopenia
- loss of trabecular architecture
- new bone apposition
- involucrum, and
- sinus tract formation.

These parameters were chosen based on the findings published by Kothari (2001).[7]

Bacterial Culture

Data of bacteriological findings were extracted from the microbiological study published by Pagel (2015).[1]

Statistical Analysis

The chi-squared test was used to define the statistically significant correlations between nominal characteristics using a software programme for statistical analysis (IBM SPSS Statistic 23, IBM Corporation, Armonk, USA). Probability values were reported, with $P<0.05$ considered statistically significant.

RESULTS

Species, Breed, Weight, Age, Sex and Antibiotic Therapy

Fifty one dogs and 14 cats fulfilled the inclusion criteria and were enrolled in the study

Table 1. *A survey of patients with osteomyelitis*

No.	Breed, Weight, Age, Sex	Type of Fracture / Postoperative antibiotics	Clinical signs	Radiographic signs	Pus on aspiration	Bacterial culture
1	mixed-breed; 40kg; 10,6 years; male neutered	tibia/fibula fracture, closed, diaphyseal, oblique	inappetence, lethargy, fever, localised swelling, pain, lameness	soft tissue swelling, lytic lesions, involucrum	positive	*Stapylococcus pseudintermedius, (MRSP)*
2	Shar Pei; 22kg; 7,3 years; female neutered	radius/ulna fracture, closed, diaphyseal, transverse, cefazolin	localised swelling, pain, lameness	soft tissue swelling, periosteal thickening, lytic lesions, new bone apposition	Not performed	*Staphylococcus pseudintermedius*
3	Leonberger; 53kg; 3 years; male	tibia/fibula fracture, closed, diaphyseal, transverse	localised swelling, pain, lameness	soft tissue swelling, lytic lesions, sinus tract formation	positive	*Staphylococcus pseudintermedius*
4	Labrador R.; 37kg; 11,8 years; female neutered	tibia/fibula fracture, closed, diaphyseal, doux étage; amoxicillin/clavulanate	localised swelling, pain, lameness	soft tissue swelling, lytic lesions	positive	*Staphylococcus pseudintermedius*
5	German Shepherd; 24kg; 0,7 years; male	humerus Y-fracture, closed	inappetence, lethargy, fever, localised swelling, pain, lameness	soft tissue swelling, lytic lesions, sinus tract formation	positive	*Staphylococcus pseudintermedius, Pseudomonas aeruginosa, Enterococcus sp.*

group. Six dogs had two implants. In three dogs, the implants were removed at the same time. In three dogs the time of explantation was different. In three dogs and in two cats the fractures were open (Grade 1) at the time of presentation. In total, 71 x-rays were assessed and 71 plate implants from 65 patients microbiologically examined. The implants were removed in 68 operations.

From 14 cats, 10 were European shorthair, 2x Persian cat, 1x Norwegian cat and Abyssinian cat. From 51 dogs 15 were mixed-breed, 2x Golden Retriever, Staffordshire Bullterrier, Poodle, Yorkshire Terrier, German Shepherd, Galgo Español, Irish Setter and Collie and 18x other breed. The mean weight of the dogs was 23,6 ± 14,5 kg and mean age 4,0 ± 3,1 years. In cats 4,7 ± 1,6 kg and 3,9 ± 3,6 years, respectively. Two cats were male, eight male neutered, two female, and two neutered female. Eighteen of the 51 dogs were male, 9 male neutered, 18 female, and 6 spayed female.

Thirty minutes prior to surgery, antibiotics were intravenously applied in all animals. This was then repeated every 90 minutes during operation time. Amoxicillin/clavulanate was used in 60 (88,2 %) operations and cefazolin in 8 (11,8 %) operations as a preoperative antibiotic. Primarily amoxicillin/clavulanate was used as a perioperative antibiotic; in problems with availability, cefazolin was chosen as a substitute. Thirty patients were further given antibiotics after surgery. In 23/30 (77,4%) patients amoxicillin/clavulanate; 3/30 (9,7%) cefazolin; 2/30 (6,5%) marbofloxacin, 1/30 (0,96%) enrofloxacin and 1/30 (0,96%) trimethoprim/sulfonamide were utilised. Only animals with additional injuries received postoperative antibiotics. The therapy of choice was again amoxicillin/clavulanate or cefazolin. If the animals had been pre-treated, therapy was continued with the beforehand chosen antibiotic.

Osteomyelitis

Five dogs (5/51; 9,8%) and no cats (0/14; 0%) showed osteomyelitis (Table 1). Two dogs were male, one male spayed and two female spayed. The mean age of the dogs with osteomyelitis was 6,6 ± 4,7 years, and the mean weight was 35,2 ± 12,6kg. Three of five patients had a tibia/fibula fracture, one radius/ulna fracture, and one elbow Y-fracture. These were all closed at the time of presentation. The most common clinical signs were localised swelling (5/5), local pain (5/5) and lameness (5/5). Systemic symptoms (inappetence, lethargy, and fever) were shown in two patients (2/5). In all patients, (5/5) soft tissue swelling and lytic lesions were present on radiographs. In two dogs (2/5), a sinus tract formation was visible. Involucrum, periosteal thickening and new bone apposition were only once represented. Pus was aspirated in four cases (4/5). In one case, aspiration was not performed. Bacterial cultivation yielded St pseudintermedius in all cases (5/5), which in one case was identified in being a methicillin-resistant phenotype (MRSP). In one case a mixed culture (St intermedius, P aeruginosa, Enterococcus sp) was present. Postoperative antibiotic prophylaxis was performed in 2/5 patients (amoxicillin/clavulanate; cefazolin, respectively).

DISCUSSION

Five (9.8%) of the dogs and no cats (0%) in the present study had osteomyelitis. Overall 5 of 65 animals (7,8%) were affected. According to the literature, this complication is specified at 0.6% and 14.8%.[8-10] The age of the dogs with osteomyelitis was on average 6,6 ± 4,7 years, and mean weight was 35,2 ± 12,6kg. This is consistent with the data described by Smith et al (1978)[11] and Bardet et al (1983).[12] Interestingly, the fractures were initially closed in all patients with osteomyelitis, but 2/5 patients had a concurrent soft tissue injury and received postoperative antibiotics.

In any animal with an open fracture osteomyelitis develops. This reflects the fact, that the presence of bacteria in bone alone is not enough to cause disease. It appears that bacteria, vascular occlusion secondary to septic thrombosis, and the resulting bone necrosis, are equally important factors in

establishing infection.[13,14] As in Smith et al (1978),[11] the most common radiographic findings were osteolysis (5/5) and soft tissue swelling (5/5) in this study. The explants of dogs with osteomyelitis were most commonly infected with S pseudintermedius. According to available sources, staphylococci are the most frequent cause of osteomyelitis.[9,15] In a previous study by Pagel (2015),[1] microorganisms were detected in 35 (49.3%) of 71 explants by 2 cats and 31 dogs (n=33; 50,8%). This is significantly higher (P<0,01) compared to the number of patients with osteomyelitis. Bacteria colonising the metallic implants in dogs may have been present or introduced at the time of the initial operative procedure, or may have been haematogenously spread after implant application.[16] The bacterial wound flora and the local condition of the orthopaedic wound are interrelated. If either factor exceeds the tolerable threshold, infection will become manifest. The level of this breaking point may depend upon certain systemic host factors, surgical technique, type of implanted device, postoperative care, and antibiotic selected for orthopaedic surgery.[17] Nevertheless, bacteria on an implant can persist despite an effective host immune system and appropriate antimicrobial chemotherapy. This characteristic is biofilm-mediated, whereby the infective bacteria are able to produce a polysaccharide mucoid peribacterial film (glycocalyx). The glycocalyx promotes bacterial growth and adherence to a foreign material.[16]

The minimum bactericidal concentration of antimicrobial substances is higher for microorganisms in a biofilm.[18,19] This supports the microbiological findings from Pagel (2015).[1] This study reveals, that postoperative antibiotic treatment has a non-significant effect on the presence of the bacteria on the implants. Such cryptic infections are characteristically focalised, seldom cause bacteraemia or clinical signs of toxaemia, and usually persist until the foreign material is removed.[20] Although cryptic infection itself must not pose any clinical problem, whenever the host defence mechanisms are decreased by any causes (ie, systemic diseases, hypersensitivity to metallic implants), the bacteria may be recalcitrant and cause the infection leading to implant failure[16] or metastatic infection due to the formation of daughter colonies.[21]

CONCLUSION

In conclusion, this study shows that the incidence of bacterial colonisation on metallic plate implants is significantly higher than the incidence of osteomyelitis. The results provide evidence that although the majority of animals were clinically healthy, bacteria were nevertheless present on the implants. However this equilibrium can easily be impaired. From this point of view, a timely explantation of plate implants is recommended.

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