Superficial pyoderma in cats and dogs: A retrospective clinical study

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ABSTRACT

Superficial pyoderma is a common complication of a range of feline and canine skin diseases. The objective of the present study is to retrospectively evaluate bacterial and fungal skin culture samples in superficial pyoderma cases of cats and dogs and to reveal in detail the pathogens and their susceptibility and/or resistance to antimicrobials, as well as demographic data and clinical symptoms of the patients. Medical records of 28 cats and 35 dogs meeting the criteria for inclusion were reviewed. *Staphylococcus spp.* and *Trichophyton* species were found to be the most common cultured microorganisms in both cats and dogs. Antimicrobial resistance was determined both in cat and dog samples. As a result, it has been demonstrated that skin culture is particularly important for the management of diagnosis and treatment processes and the regulation of treatment protocols in pyoderma in terms of preventing the increasing antibiotic resistance in recent years and thus protecting both human and animal health.

Introduction

While pyoderma typically refers to pyogenic changes occurring in the epidermis and/or follicular epithelium, superficial pyoderma is confined to the superficial portion of the hair follicle (1). Although mostly used to describe bacterial infections, fungi may also cause pyoderma lesions (21, 23). For the formation of superficial pyoderma, microorganisms must be able to adhere to the skin surface and colonize. In most cases, pyoderma develops secondary to various causes such as trauma, hormonal changes, impaired immune system, parasitic infestations, exposure to allergens, and follicular dysplasia (17, 28).

In pyoderma, a chronic and recurrent inflammatory process may easily occur. Antibiotics are often used empirically for the treatment of infectious bacterial diseases, leading to multidrug resistance in many cases. The threat posed by increasing antimicrobial resistance adds a new dimension to the public health implications of the management of cat and dog pyoderma and creates the need to develop new strategies for patient management in clinics (12). Therefore, deeper examinations including skin cultures in dermatological lesions become a great need, especially considering the decrease in the ability to effectively treat pyoderma.

The aim of the present study is to reveal the microorganisms and their susceptibility and/or resistance to antimicrobials in superficial pyoderma cases of cats and dogs referred to our clinics and to evaluate the possible effects of breed, age, gender, sterilization status, and seasonal factors on the disease.

Materials and Methods

The records of feline and canine superficial pyoderma cases brought to Ankara University Faculty of Veterinary Medicine Small Animal Teaching Hospital between June 2018 and June 2022 were reviewed retrospectively from the hospital software database. The keywords 'feline' and 'canine' for animal species and 'pyoderma' for diagnosis were used to identify the cases to be included in the study. Superficial pyoderma was defined as animals presenting with dermatological complaints with the presence of neutrophils and/or intracellular bacteria on skin surface cytology (31). Among those, only the animals with the results of skin bacterial and fungal cultures and antibiogram analysis were included in the study. Of animals with multiple records, the data from the first visit were considered to avoid duplication. Demographic data, clinical signs, the season of presentation, age of onset, and duration of dermatological problems were evaluated. The localization and type of cutaneous lesions, the manifestation of the disease, as well as skin surface cytology and skin culture results were reviewed. All the examinations and procedures were performed after obtaining a written consent form from the owners (Ankara University Animal Experiments Local Ethics Committee Decision Number: 2022-14-132 & 2022-16-151).

Bacterial Culture of the Skin: All skin samples are taken by following a routine method in our clinic. The skin swabs were taken very carefully to avoid possible contamination. Surface skin lesions were harvested by rotating a swab across them for 5 seconds and placed in a sterile container (8). The samples were sent to the laboratory immediately and, cultured within one hour. Inoculation was done on 5% Sheep Blood Agar and MacConkey Agar for bacterial growth from the swabs. After the incubation, the Petri dishes were incubated at 37°C for 24-48 hours. After the colonies formed, Gram staining was performed and, bacteria were classified as Gram-positive and Gram-negative. *Staphylococcus spp*. were separated from other bacteria by performing oxidation-fermentation tests and catalase tests. Afterward, coagulase, maltose, and mannitol tests were performed on *Staphylococcus spp* (29).

Fungal Culture of the Skin: The swabs were inoculated on Sabouraud Dextrose Agar (SDA) for fungal growth and then the Petri dishes were incubated at 25 °C for 4 weeks. During the incubation, the formed colonies were identified according to their macroscopic and microscopic features including size, duration, structure, and pigmentation. Microscopic examination involved using Lactophenol Cotton Blue solution to assess dermatophytes at the genus level, focusing on features like hyphae structures, macroconidia, and spore formations within The swabs were inoculated on Sabouraud Dextrose Agar (SDA) for fungal growth and then the Petri dishes were incubated at 25 °C for 4 weeks. During the incubation, the formed colonies were identified according to their macroscopic and microscopic features including size, duration, structure, and pigmentation. Microscopic examination involved using Lactophenol Cotton Blue solution to assess dermatophytes at the genus level, focusing on features like hyphae structures, macroconidia, and spore formations within the fungal colonies (24).

Antimicrobial Susceptibility Test: The antimicrobial susceptibility of bacterial isolates was tested on Mueller-Hinton agar (Merck, USA) using the disk diffusion method according to CLSI guidelines from 2013 (2). The following panel of antimicrobials was used: amoxicillin (10 µg/disk), amoxicillin/ clavulanic acid (30 µg/disk), ampicillin (10 µg/disk), Clindamycin (10 µg/disk),ciprofloxacin (5 µg/disk), enrofloxacin (5 µg/disk), danofloxacin (5 µg/disk), erythromycin (15 µg/disk), gentamicin (10 µg/disk), imipenem (10 µg/disk), lincomycin (15 µg/disk), meropenem (10 µg/disk), mupirocin (200 µg/disk), novobiocin (30 µg/disk), oxytetracycline (30 µg/disk), penicillin (10 units/disk), streptomycin (10 µg/disk), tetracycline (30 µg/disk). Staphylococcus aureus reference strain ATCC 25923 was used for quality control in the study.

Results

Prevalence, Signalment, and Seasonality: A total of 88 cats and 59 dogs with the diagnosis of superficial pyoderma were reviewed in the study. Of these, 28 cats and 35 dogs met the criteria for inclusion. This account for 31.8% and 59.3% of all suspected cases of cats and dogs, respectively. The age, breed, gender, and sterilization status were shown in Table 1.

Age at the time of diagnosis ranged from 9 months to 11.5 years in cats and 10 months to 18 years in dogs. The median age was 4.3 years in cats and 6.8 years in dogs. Upon presentation, the duration of skin lesions ranged from less than 1 month to more than 2 years, with a median duration of 5 months in cats and from 1 month to more than 4 years with a median of 11 months in dogs.

When the distribution of the patients in terms of seasons was evaluated, it was determined that the presentation of pyoderma in cats was higher in winter (from December to February; 10/28, 35.7%) followed by summer (from June to August; 7/28, 25%), spring (from March to May; 5/28, 17.8%) and autumn (from September to November; 6/28, 21.4%). In dogs, the incidence of the diagnosis was higher in winter (15/35, 42.8%), followed by summer (9/35, 25.7%), spring (7/35, 20%), and autumn (4/35, 11.4%).

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Table 1. Breed, age, gender and, sterilization status of cats and dogs included in the study.

Cats	Dogs
Breed	
Domestic short hair (n=18); Scottish Fold (n=5); British Shorthair (n=3); Norwegian Forest (n=1); Bombay (n=1)	Mix-Breed (n=6); Golden Retriever (n=6); Terrier (n=4); Turkish Kangal Shepherd (n=3); Pug (n=3); German Shepherd (n=2); Labrador Retriever (n=2); Akita (n=1); American Cocker (n=1); Belgian Shephard (n=1); French Bulldog (n=1); Hungarian Hound (n=1); King Charles Spaniel (n=1); Poddle (n=1); Shar-Pei (n=1); Siberian Husky (n=1)
Age (mean± std)	
4.34±2.22	6.80±4.09
Gender and Sterilization Status	
Female active / spayed 7/6 Male active / castrated 14/1	Female active / spayed 11/1 Male active / castrated 21/1

Clinical Signs: In cats, the most common complaints and findings at the presentation were pruritus (n=22/28), multifocal alopecia (n=22/28), crusting (n=20/28), pustules (n=19/28), effusive lesions (n=13/28), and hyperpigmentation (n=12/28) while crusty and effusive lesions (n=32/35), scratching (including licking and biting if the area is accessible; n=28/35), multifocal alopecia areas (n=25/35) and hyperpigmentation (n=22/35) were the most common complaints in dogs.

In cats, cutaneous lesions were mostly multifocal (n=11). Apart from these, regions, where specific localization was identified were; head/neck (n=7), inguinal region (n=6), limbs and axillar region (n=4), and ventral abdomen (n=1). In dogs, the specific lesions were mostly located on the inguinal region (n=11), limbs and axillar region (n=9), head/neck (n=4), ventral abdomen (n=3), and tail (n=1). The number of dogs with multifocal lesions was noted as 7.

Bacterial and Fungal Culture Findings: Bacterial growth was observed in 17 of 28 cats. In two of these cats, concomitant colonizing bacteria were grown, while a single bacterial type was determined in the remaining cats. The most frequently recovered bacterial genus was *Staphylococcus spp.* (n=15) while *Pseudomonas spp. (n=4)* and *Corynebacterium spp. (n=2)* growth was also observed. Among the studied samples, *Staphylococcus aureus* (11/17, 64.7%) represented the most frequently recovered bacterial isolates. The other staphylococci recovered from the studied animals was *Staphylococcus pseudointermedius (S. pseudointermedius)* isolated from 4 samples (23.5%).

Fungal species were recovered from 16 of the studied cats (57.1%) and more than one fungal microorganism grew in 5 of these cats. *Trichophyton* species were found to be the most common fungal microorganism in this study (6/16 isolates, 37.5%). The other microorganisms grown were found to be *Aspergillus* (5/16, 31.25%) and *Penicillium* (4/16, 25%) followed by overgrowth of *Microsporum, Alternaria*, *Cladosporium*, *Candida* and, *Rhizopus* species each in one sample (1/16, 6.25%), Yeast overgrowth was also seen in one cat. The list of isolated bacteria and fungi from feline patients are presented in Table 2.

In dogs, bacterial growth was observed in 29 out of 35. In 3 dogs concomitant colonizing bacteria growth was seen. The most detected bacterial genus was *Staphylococcus* (26/29, 89.65 %) followed by *Pseudomonas* (3/29; 10.34%) and *Streptococcus* and *Proteus* were detected in one dog each (1/29; 3.44%). Among those, *S. pseudointermedius* represented the majority of the isolates (13/29; 44.82%).

Fungal pathogens were grown in 17 dogs and more than one microorganism growth was identified in 8. *Trichophyton* species (8/17; 47.05%) were found to be the most common fungal microorganism as it is in cats. This was followed by *Penicillium* (5/17; 29.41%), which was observed as a mixed infection with *Microsporum gypseum* growth in one dog, *Alternaria* (5/17; 29.41%), *Aspergillus* (3/17; 17.64%), *Mucor* (2/17; 11.76%), *Rhizopus* (2/17; 11.76%), *Candida* (1/17; 5.88%) species and yeast (n=2) growth. Bacterial and fungal culture results of the dogs are presented in Table 3.

Antimicrobial susceptibility test: The antibiotics to which staphylococci are most susceptible in cats were oxytetracycline (12/17; 70.58%), enrofloxacin (11/17; 64.7%), and danofloxacin (7/17; 41.17%). All staphylococcal isolates were susceptible to at least 2 antimicrobial agents. A total of 10 isolates were resistant to at least one agent. Antimicrobial resistance was most determined against ampicillin (50%), followed by amoxicillin (30%), lincomycin (30%), oxytetracycline (30%), and enrofloxacin (30%). Six of the resistant samples of staphylococci were determined to be resistant to three or more antimicrobials which are defined as multi-resistance in this presented study.

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Table 2. Bacteria and fungi isolated from skin samples from cats.

Cat	Bacterial Culture	Fungal Culture
1	*Staphylococcus aureus*	-
2	*Staphylococcus aureus*	-
3	*Staphylococcus aureus*	-
4	-	*Aspergillus fumigatus Trichophyton mentagrophytes*
5	*Staphylococcus aureus*	-
6	*Staphylococcus pseudointermedius*	-
7	*Staphylococcus aureus*	-
8	*Staphylococcus aureus*	-
9	*Pseudomonas spp.*	*Trichophyton mentagrophytes*
10	-	*Alternaria spp.*
11	-	*Penicillium spp.*
12	*Staphylococcus pseudointermedius*	*Rhizopus spp.*
13	*Staphylococcus pseudointermedius*	-
14	-	*Penicillium spp.*
15	*Staphylococcus pseudointermedius*	-
16	-	*Trichophyton rubrum*
17	-	*Aspergillus niger*
18	*Staphylococcus aureus Corynebacterium spp.*	-
19	*Staphylococcus aureus*	*Trichophyton mentagrophytes Aspergillus fumigatus Alternaria spp.*
20	-	*Penicillium spp.*
21	-	*Trichophyton mentagrophytes*
22	-	*Penicillium spp.*
23	*Staphylococcus aureus*	*Candida spp. Cladosporium spp.*
24	-	*Microsporum ferrugineum*
25	-	*Aspergillus niger Penicillium spp.*
26	*Staphylococcus aureus*	*Aspergillus niger*
27	*Staphylococcus aureus*	-
28	*Staphylococcus aureus*	-

Table 3. Bacteria and fungi isolated from skin samples from dogs.

Dog	Bacterial Culture	Fungal Culture
1	*Staphylococcus intermedius*	*Penicillium spp.*
2	*Staphylococcus epidermidis*	*Candida albicans*
3	-	*Aspergillus fumigatus*
4	*Pseudomonas aeruginosa*	-
5	*Staphylococcus intermedius*	*Penicillium spp. Microsporum gypseum*
6	*Staphylococcus epidermidis*	-
7	*Staphylococcus aureus Streptococcus canis*	-
8	*Staphylococcus pseudointermedius*	*Trichophyton mentagrophytes Aspergillus niger Alternaria spp.*
9	*Staphylococcus intermedius*	*Aspergillus fumigatus*
10	-	-
11	*Staphylococcus intermedius*	*Trichophyton mentagrophytes Alternaria spp.*
12	-	*Trichophyton mentagrophytes Alternaria spp.*
13	*Pseudomonas aeruginosa*	-
14	*Proteus mirabilis*	-
15	*Staphylococcus pseudointermedius*	-
16	*Staphylococcus aureus*	*Penicillium spp.*
17	*Staphylococcus aureus*	-
18	*Staphylococcus epidermidis*	*Penicillium spp.*
19	*Staphylococcus aureus*	-
20	*Staphylococcus pseudointermedius*	*Rhizopus spp.*
21	*Staphylococcus epidermidis*	-
22	*Staphylococcus epidermidis*	*Rhodotorula glutinis*
23	*Staphylococcus intermedius*	-
24	*Staphylococcus intermedius*	-
25	*Staphylococcus aureus*	*Trichophyton rubrum Penicillium spp.*
26	*Staphylococcus epidermidis*	-
27	*Staphylococcus pseudointermedius Pseudomonas aeruginosa*	
28	-	*Aspergillus niger*
29	*Staphylococcus epidermidis*	-
30	-	*Aspergillus fumigatus Trichophyton mentagrophytes*
31	*Staphylococcus intermedius*	*Rhizopus spp.*
32	-	*Alternaria spp. Trichophyton rubrum*
33	*Staphylococcus intermedius*	*Alternaria spp. Trichophyton mentagrophytes*
34	*Staphylococcus intermedius*	*Trichophyton mentagrophytes*
35	*Staphylococcus aureus*	-

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All staphylococcal strains cultured from dog samples were susceptible to at least 2 antimicrobials listed enrofloxacin (20/29; 68.96%), oxytetracycline (12/29; 41.3%) and ciprofloxacin (7/29; 24.13%). Antimicrobial resistance against staphylococci was most prevalent against amoxicillin (34.48%), followed by meropenem (13.79%) and metronidazole (10.34%). Twelve samples showed multidrug resistance in dogs. All *Pseudomonas spp*. cultured samples were susceptible to ciprofloxacin while resistant to ampicillin and/or amoxicillin. While *Proteus* and *Streptoccous* isolates were susceptible to enrofloxacin, they were resistant to amoxicillin and ampicillin, respectively.

Discussion and Conclusion

According to the results of the presented study, bacterial and/or fungal growth was observed in approximately 30% of cats and 60% of dogs who presented to our clinics with dermatological complaints with a preliminary diagnosis of pyoderma. These rates are consistent with the previous findings reported from different regions of the world (17, 20, 31).

The vast majority of the cats in this study (about 65%) were domestic shorthairs. The dominance of this breed was found to be consistent with previously presented reports of feline pyoderma (30, 31). However, it seems plausible that this is a proportional excess because of the regional adoption of this breed rather than a breed predisposition. The same assessment may also be valid for canine pyoderma cases, which were more intensely detected in mix-breed and Golden retriever dogs in this report.

One of the surprising findings in our study was the predominance of the male sex in both cats and dogs. Previous literature on pet animals do not show a clear gender predominance in the development of dermatological diseases in cats (31) or dogs (23). However, a study including 30 cats determined that pyoderma was more common in male cats than females (25). A similar finding was reported in a pyoderma study in which 60 dogs were examined and, according to this study, male dogs represent 60% of the cases (20). These findings may be explained by the fact that superficial traumas are more common in males than females, leading to the formation of pyoderma. Nevertheless, this finding is an outcome that should be considered carefully, especially in clinical practice, considering studies showing that multidrug resistance in pyoderma cases is more commonly determined in samples taken from male dogs, as well (10).

Our results showed that pyoderma can be detected at an earlier age in cats than in dogs. This trend is mostly considered to be associated with early-onset hypersensitivity in most feline patients (31). Many researchers stated the likelihood of the formation of pyoderma in dogs decreases after 5 years of age (9, 22). Although there were patients in whom the first manifestation of clinical signs begins from the age of 10 months among the dogs included in our study, the higher average age (6.8 y mean) may be associated with an increased risk of developing pyoderma as a result of the immune system declining with advancing age in the included dogs.

The incidence of dermatological problems may develop depending on the season and climate. The incidence of pyoderma cases in winter months was found to be higher in cats and dogs than in other months in this study. Contrary to our findings, previous studies show a higher frequency of pyoderma cases in warmer seasons (11, 31). This may be related to the fact that the number of patients presented to our hospital in the winter period is higher than in the summer leading the proportional differences between the presented and previously reported studies. However, it should be considered that this finding may also be related to the fact that anxiety experienced by cats and dogs due to the decrease in sunlight and sub-zero temperatures causes cold stress during winter, regardless of whether it is an indoor or outdoor pet (18).

The most common clinical signs were pruritus and multifocal lesions in cats while dogs presented crusted lesions especially localized in the inguinal and axillar region, in line with the previous reports (26, 31). This distribution corresponds to that of feline hypersensitivities and its nature of generalized localization. However, lesions are distinctly localized in bacterial pyoderma in dogs. Lesions often start in the limb, groin, and axilla, which may be due to the fact that these areas are more humid and offer a suitable environment for the proliferation of bacterial microorganisms (6). Although it is assumed that microorganisms can adhere to corneocytes in these regions more easily than other anatomical regions, it has been shown that there is no significant difference in adhesion to these regions compared to other regions, and adhesion is probably not an important factor in the susceptibility of canine bacterial pyoderma to affect specific localizations (5).

In the presented study, staphylococci are the most cultured microorganism in both cats and dogs. While *S. aureus* was the most isolated bacteria from cats, *S. pseudointermedius* was isolated in the majority of the dogs. Given the recent understanding of staphylococcal infections may be effective in the formation of atopic dermatitis in dogs, the same suggestions may be valid for cats (3). Staphylococci, if there is a predisposition to atopy, can worsen the patient's clinical condition by producing *Staphylococcus* -specific IgE and staphylococcal protein A, which can bind nonspecifically to IgE molecules on mast cells (15). Controlled prospective clinical trials are needed to further

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characterize *Staphylococcus-induced* pyoderma in both cats and dogs to advance the understanding of pyoderma lesions and related diseases such as atopic dermatitis.

Although it is known that zoonotic and multi-drug resistant strains have increased in veterinary medicine in recent years, no significant progress has been made in the control mechanisms of drug use in the control of infections in clinical practice (7, 19). However, there is a growing need to encourage the prudent and judicious use of antibiotics in pet medicine, as the recent much greater incidence of multidrug-resistant bacteria in dogs and cats highlights a significant threat (10, 19). We have revealed an increased risk of multi-drug resistance in antimicrobial susceptibility tests against *Staphylococcus spp*. Exchange and acquisition of new strains of Staphylococci may occur between pets with normal daily contact. Animals receiving antibiotic therapy may be particularly at risk for acquiring resistant organisms, as this may promote the transfer of organisms through antibiotic-induced reduction of the normal resident *Staphylococcus* population (14). This finding has an additional severe consequence as these microorganisms are mostly of zoonotic importance, in addition to the prolongation of the treatment period of patients admitted to veterinary clinics and the rapid deterioration in animal health and welfare.

In the presented study, while the bacterial isolates were mostly susceptible to enrofloxacin and oxytetracycline, the resistance was determined against ampicillin and amoxicillin in cats and dogs, respectively. Penicillin groups are antimicrobials that have been widely used in human and animal medicine for many years in the treatment of various diseases, including pyoderma (13). Although, similar to our findings, resistance to ampicillin and amoxicillin, has been reported in feline canine staphylococci infections previously (4), a study among primary care practitioners showed that in most dogs diagnosed with pyoderma, the amoxicillin group was the most commonly prescribed antibiotic for empirical therapy (27). Inappropriate use of antibiotics in pyoderma isolates increases the risk of developing multidrug resistance. Therefore, evidence of methicillin resistance in staphylococci, although still rare in veterinary medicine, should be carefully evaluated in animals, considering the risks to human health (16).

In the presented study, besides bacterial agents, fungal agents were also evaluated. *Trichophyton* was the most frequently detected dermatophyte in cats and dogs. The high isolation rates obtained in this study showed that dermatophytes still pose a problem in cats and dogs. Since the majority of fungal agents isolated from domestic animals also cause disease in humans, these cases should be followed carefully, and the effectiveness of fungal infections should be taken into account when designing the treatment protocol in pyoderma cases.

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Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

NKY and BB planned the study, reviewed the patient files and contributed to the interpretation of the results. NKY took the lead in writing the manuscript. NKY and BB provided critical feedback and helped shape the research, analysis and manuscript.

Data Availability Statement

The data supporting this study's findings are available from the corresponding author upon reasonable request.

Ethical Statement

This study was reviewed by the Local Animal Ethics Committee of Ankara University (Decision number: 2022-14-132 & 2022-16-151).

Animal Welfare

The authors confirm that they have adhered to ARRIVE Guidelines to protect animals used for scientific purposes.

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